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SOUNDS OF SHORTWAVE

SIDE A

A

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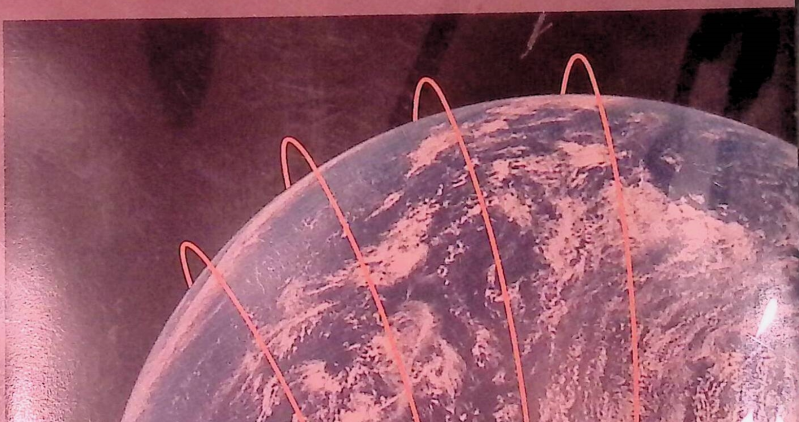
Radio Shack

All about locating and listening to worldwide shortwave.

LISTENING TO SHORTWAVE



By Ken Winters, N5AUX

Developed and Published by Master Publishing, Inc.

Includes Facts on How to Get Started Listening to Shortwave

LISTENING TO SHORTWAVE

Contents:
- **An easy-to-read and understand 64-page book**
- **A C-20 cassette with actual sounds of shortwave radio.**

Join in on the excitement of listening to shortwave radio! Find out about the strange pulses, beeps, and chirps that, in addition to voice, are present on the shortwave bands. Thrill to locating and listening in on messages from around the world.

LISTENING TO SHORTWAVE
Describes it all

Shows how, where and when to find stations. Tells you about receivers, antennas, and the different types of shortwave broadcasts. Learn what shortwave radio is, how radio waves are generated, and how the waves move through the air. Know what frequency and wavelength are, and how the radio frequency spectrum is divided into its different bands. Covered in six chapters as follows:

1. Listening to Shortwave – The Benefits
2. Where to Find Shortwave Signals
3. What Am I Listening To?
4. Expanded Listening on VHF and UHF
5. Equipment for Listening
6. Amateur Radio

About the Author

Ken Winters has been interested in listening to shortwave since his teenage years. This led him to ham radio, and he holds an Advanced Class license, N5AUX. He has been editing and publishing *THE D/FW FREQUENCY LIST* since 1983, and has authored several technical magazine articles. He served as contributing editor to the *1992 Communications Guide* by Popular Communications.

Ken has a wide variety of radio communications experience. He is very active in ham packet radio. He is the Emergency Coordinator for Tarrant County ARES, and is active in RACES—the radio amateur civil emergency service. He assists in training and disaster preparedness, and is active in the *SKYWARN* program to assist the weather service.

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64 page book
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Radio Shack®

All about locating and listening to worldwide shortwave.

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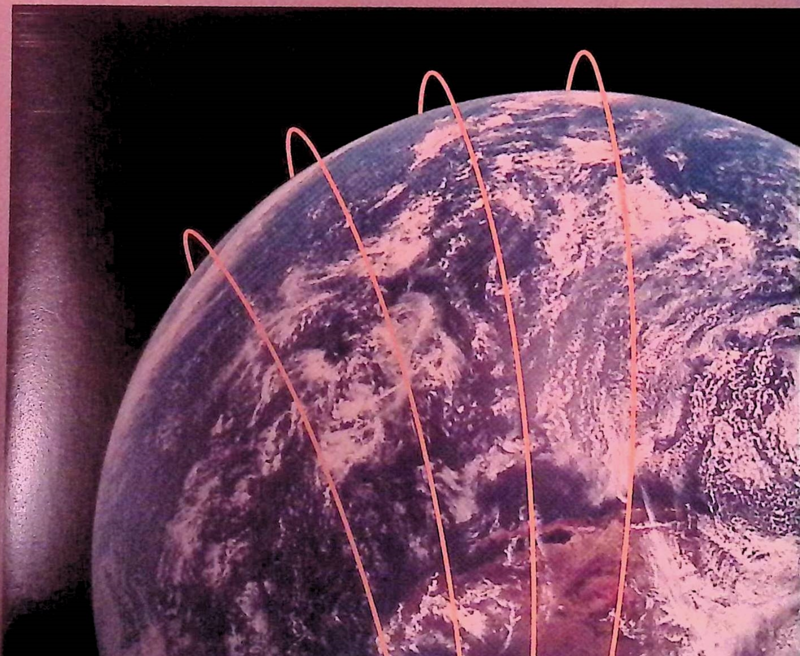

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LISTENING TO SHORTWAVE

by
Ken Winters, N5AUX

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Preface

Shortwave listening is one of the most interesting and entertaining hobbies you will ever discover. There is never a dull moment when the world is at your fingertips, and that's just what a shortwave receiver delivers. Imagine being able to listen to the action as rescuers race to save a sinking ship or as rebels attack the palace guards or explorers reach the ocean depths or the edge of the universe.

Shortwave listening is fun. You can collect postcards and stamps from every country in the world by sending reception reports to international shortwave broadcasters. No matter what time of the day or night you want to listen, someone somewhere is transmitting a signal that will capture your attention and your imagination.

You can listen to real-life drama unfolding as it happens and hear details about world events that are only mentioned briefly in the evening newscasts on TV. You can listen to hams all over the world talking with each other about where they live, work and play. You can tune in exotic music from faraway lands and listen to the sounds and culture and customs of foreign countries as shortwave radio brings you the magic, romance and adventure of traveling at light speed to anyplace you want to go.

You don't need a technical background to operate a shortwave receiver and you won't need an elaborate antenna. Of course, an outdoor antenna helps, but modern technology has made worldband receivers easy to operate and sensitive enough to pull in stations from the other side of the world. Advances in technology have also reduced the cost of shortwave receivers and you can find one to suit your pocketbook as well as your level of interest.

In this book, we'll show you some of the many things you can find on the shortwave bands, how to identify the different kinds of signals you'll hear and how to select your very first shortwave receiver. We'll cover all the shortwave bands and even some of those above and below the shortwave frequencies for comparison. We'll talk about ham radio and scanners and tell you how to listen to the astronauts working in space.

From around the corner to around the planet, listening to shortwave brings you the world. Find out how easy it is and how much fun it can be. Visit your local Radio Shack dealer and talk with your neighborhood ham operator about the exciting world of listening to shortwave. We think you'll like what you find.

KW
MPI

Listening to Shortwave— The Benefits

Introduction

Imagine the excitement of being in the cockpit of a Stealth fighter jet streaking across the dark desert sky toward a target deep in the heart of enemy territory with hundreds of radar stations searching for you. Thousands of eyes straining against the darkness, looking for the first opportunity to launch their deadly missiles at your small, dark plane. They know you are coming. They are waiting for you. Almost casually, you gently press one of the buttons on your control stick, and, talking in a calm, steady voice, ask your controller for an update. From hundreds of miles away, even higher than your own plane, a friendly voice assures you that no one has spotted you, you're in the clear and you're now only five miles from your target. You close in; target in sight. Laser-guided bombs are released, and as they fall away from your plane you turn toward home and watch your computer screen track the lethal warheads straight to the spot you chose moments before.

You know that's how it happened, because you saw it all on television, right? We've all seen the reruns of laser-guided bombs splitting open reinforced bunkers, or taking out bridges and tanks. We watched Patriot missiles soaring into the clouds to intercept incoming Scud missiles. And who can forget the image of the night-vision camera shot of tracers streaking upwards into the night sky over Baghdad.

Listening Benefit No. 1 — Direct Information

But you knew it WHEN it happened. You heard it on your shortwave receiver as it happened. You listened to the pilots and controllers and even the aircraft carriers as the drama unfolded on the other side of the world. You had the information straight from the source hours before your neighbors saw it on TV without having to wait for it to be processed through news agencies, script editors, and other media modifiers.

Before, during and after the Persian Gulf War, shortwave radio was used by the military, the press, and the politicians. At times, the only communications available were via shortwave radio. The signals traveled all the way around the world to your very own world band receiver. You listened in as pilots reported strikes, as ships launched and retrieved their warplanes, and as kings, prime ministers, politicians, rebels and reporters all bandied their own particular line of rhetoric. The excitement, the joy, the tragedy and the propaganda—the whole story—was covered. Shortwave radio became your first communications link with the outside world as you followed these important events.

Shortwave radio is able to provide a window to the world during the most trying times. Earthquakes and volcanoes, the most devastating ravages of nature, are well-known for their disruption of normal lines of communications, yet, when they occur, shortwave radio is most often the only communication link with the outside world. Whether it's a terrorist bomb exploded in a crowded airport, or the hijacking of a ship on the high seas, or, perhaps, even a war, shortwave radio is the first line of communication. And you can be a part of it and hear it all, as it happens, on your world band receiver.

Listening Benefit No. 2—Variety of Information

Everything you find on shortwave radio is not quite as dramatic as the Persian Gulf war. There are programs of a more gentle nature: talk shows with commentaries on current events from all around the world; music from exotic, faraway lands; scientific programs hosted by renowned scientists; and a broad spectrum of religious programs. There are utility stations, ships at sea, long-range weather forecasts, hurricane tracking stations, and Amateur Radio. You can even hear both local and distant telephone conversations on shortwave frequencies, and, in addition, all manner of strange and mysterious sounds, including, a few from outer space!

With the high level of visibility of the space program, interest in monitoring space shuttle operations on shortwave frequencies has increased considerably. During most flights of NASA's Space Shuttles, you can find live audio relays of the communications between the shuttle and mission controllers on several shortwave frequencies. NASA's communications networks cover each mission from before takeoff until after landing. You can listen in as the crew discusses minor problems with the engineers on the ground and hear the solutions relayed to the astronauts. Modifications to the flight plan, the experiments, and other aspects of each flight make each new mission of America's space program more realistic and more interesting when you hear it as it happens.

Listening Benefit No. 3—A Fun Hobby

What is shortwave radio? How do signals from the other side of the world get to you? How can you hear them? And what is so interesting about shortwave radio? It turns out that shortwave radio is really not that much different from your own AM-FM radio. In fact, all of the radio frequencies we call shortwave lie right there in between the familiar "AM" and "FM" radio bands we listen to every day. Although you do need a different kind of radio to pick up shortwave signals, tuning in distant lands is as easy as dialing in your favorite rock-and-roll or "Golden Oldies" station. You simply turn the dial listening for something interesting, or you select a specific station. It's that easy.

National and International Signals

You may have noticed as you tune your AM radio, especially at night, how signals from distant cities sometimes come in as loud and clear as local ones. Radio signals seem to travel longer distances at night and it is not uncommon for a listener in, say, Austin, Texas, to hear a radio station in Dallas, Texas, Tulsa, Oklahoma, or even Anchorage, Alaska!

International shortwave signals are like that too, with signals from around the world coming in like gangbusters when conditions are right. As reception changes, mainly influenced by the time of day, some stations will fade out and others will get stronger. There is such a wide variety of international radio signals abundant in the shortwave

bands, that many hobbyists enjoy tuning in the weakest signals instead of the strongest ones. They enjoy spending hours searching the bands, bypassing all the strong stations and listening carefully for the "rare ones".

Worldwide QSLs

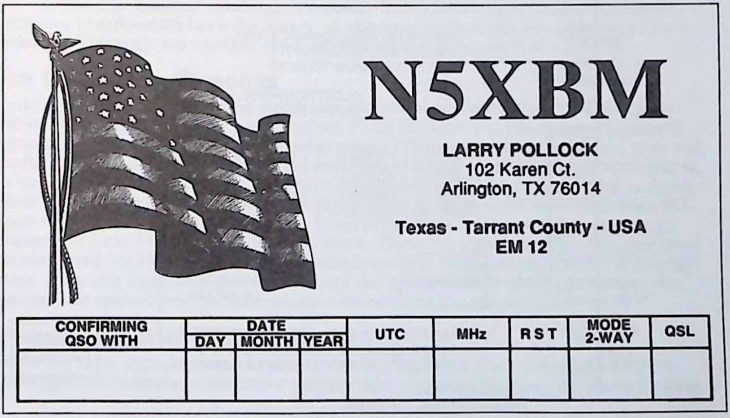
Most shortwave station broadcasters are concerned about how well their stations are working and they appreciate getting reception reports from listeners all around the world.They often send confirmations, called "QSL cards", in return. An example is shown in *Figure 1-1*. In fact, one of the most interesting parts of the listening to shortwave hobby is collecting these QSL cards from all over the globe.

QSL cards are like postcards and they often have pictures of the actual station or of some famous landmark of the station's country on the front. They often describe the radio station, its programs and schedules, and even some of the culture of their country. Stamp collectors find QSL cards to be a rich source of foreign stamps, and each of these two hobbies can be credited with "recruiting" new members from the other.

Intriguing Signals

For those with more technical interests, tuning in some of the other types of signals found on the shortwave bands is intriguing. Some of the sounds you will hear sound like machine gun chatter while others sound like some kind of strange bird in distress. One form of a new digital signal sounds like a giant cricket chirping incessantly. With the right kind of device attached to your shortwave receiver, you can get printouts of weather satellite photographs or reams of radioteletype reports straight from the international news services.

FIGURE 1-1. QSL card.



Shortwave radio holds so many different and intriguing kinds of signals, it is almost impossible not to find something interesting, stimulating, educational, enlightening or entertaining.

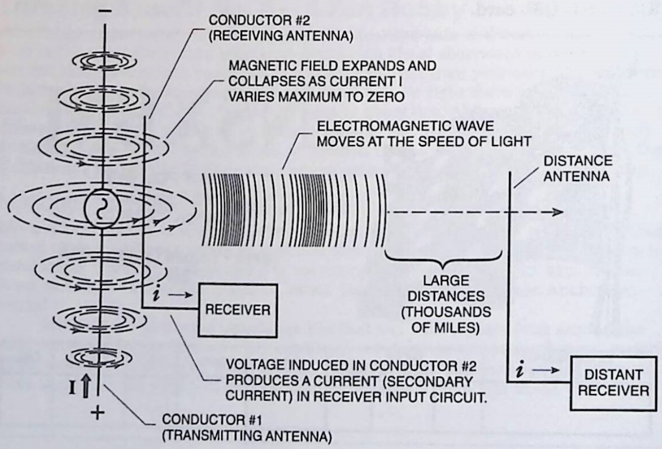
Basics of Shortwave Radio

To understand shortwave radio, let's start with how a radio signal gets from the transmitting station to the receiver. All radio signals (and television and other electromagnetic signals as well) start out as an electrical current in the radio station's own antenna. This electric current creates an electromagnetic field around the antenna and that electromagnetic field, along with a perpendicular electrostatic field, radiates out from the transmitting antenna like the waves in a pond from a rock thrown into the water. These "radio waves", as they're called, travel at the speed of light (about 300,000,000 meters per second or 186,000 miles per second), and they can travel vast distances.

Just as radio waves are created by electric currents flowing in transmitting antennas, the opposite thing happens in receiving antennas. As stated, the transmitted radio signals are waves of electromagnetic energy traveling at the speed of light. As these waves cut across a receiver's antenna, they induce a voltage in the antenna which creates an electric current in the receiving antenna's circuit that is a mirror-image of the current in the transmitting antenna.

Figure 1-2 summarizes the process. As an electric current travels through any conductor such as a transmitter's antenna wire, it generates a magnetic field around the wire as shown in *Figure 1-2*. There is also an electric field around the antenna, due to the voltage across the antenna, that is perpendicular to the magnetic field, and travels

FIGURE 1-2. How radio signals are sent from transmitter to receiver.



with the magnetic field. For simplicity, we will just deal with the magnetic field. If another wire is placed in close proximity to the first one carrying the primary electric current, a voltage induced in the second wire produces a secondary current in the circuit containing the second wire. In *Figure 1-2*, the second wire is an antenna of a receiver. If the direction or strength of the current in the first wire is changing with time, the same rate of change will be induced in the second wire. This is a simple but accurate description of how information such as voice, music, sounds and other information can be sent from one place to another using radio signals. As *Figure 1-2* illustrates, electromagnetic fields created by the transmitting antenna can be picked up miles away by the receiving antenna where they are fed to the receiver, amplified, and used to reproduce the same signals being fed into the transmitter.

Transmitter and Receiver Separation

Although the strength of radio waves is greatly diminished the farther they travel from the transmitting antenna, they can still be detected at extremely great distances. If a very sensitive instrument or receiver is used, the electromagnetic field created by the transmitter can be detected several thousands of miles away. Super-sensitive receivers are being used today to communicate with our deep-space probes such as Pioneer and Ulysses. As this book was being written, one Pioneer spacecraft was nearly 300 million miles from Earth and scientists at the Jet Propulsion Laboratory facilities in California were receiving the faint signals and recording data that took almost half an hour to reach Earth after being transmitted by the distant spacecraft's radio.

Receiver Sensitivity and Transmitter Power

Radio receivers are designed to be very sensitive to the minute electric voltages induced in their antennas by passing radio waves. Receivers are designed to be tuned to specific frequencies in order to separate all the different signals arriving at the receiver's antenna from the thousands of radio transmitters operating around the world (and beyond).

Unlike the compact, relatively low-power transmitter in the Galileo spacecraft, shortwave broadcasters have the luxury of almost unlimited power and most major stations use transmitters capable of generating several thousands of kilowatts.

The Complete Process

Suppose an announcer at a radio station speaks into a microphone. Let's summarize how you hear what he said in your receiver. First, the sound of the speaker's voice is changed into electric currents by the microphone. These electrical signals are then fed into the radio transmitter, amplified, converted to a much higher frequency and sent to the transmitting antenna. There the audio signal (now riding on a radio signal of much higher frequency) is changed from an electric current in the antenna into electromagnetic waves which radiate from the antenna. Eventually, these waves pass by a receiving antenna, are picked up, and sent to the receiver. There the signals are isolated, amplified and converted back into signals in the audio frequency range. After additional amplification, the audio signals drive a speaker and the listener hears a reproduction of the same sounds spoken into the microphone connected to the transmitter.

Frequency and Wavelength

Shortwave radio signals are generally referred to by either their frequency or their wavelength. For example, a shortwave station might announce that they are "broadcasting

on the 19-, 21-, and 49-meter bands." Ships at sea, on the other hand, will use specific frequencies, like 8.281 MHz or 12.577 MHz. We'll talk more about the relationship of wavelength and frequency in a moment, but for now, let's look at frequency.

Frequency

A simple way to look at frequency is represented in *Figure 1-3a*. Here we see a thin strip of stiff metal clamped in a vise and plucked to make it vibrate. As it vibrates, the strip moves first in one direction, then the other. If we refer to one direction as positive and the opposite direction as negative, the sound pressure waves created by the vibrating strip look like those shown in *Figure 1-3a* and *1-3b*. We see that the faster the vibration, the closer together are the air pressure waves produced by the vibrating strip. These pressure waves are what carries the humming sound through the air from the metal strip to our ears. The faster the strip vibrates back and forth, the closer together the positive (and negative) pressure waves created by the vibration. The rate of vibration from the start of swing through maximum positive, maximum negative and back to the starting point is called the frequency. In radio, such "vibration" is called oscillation. The oscillation of any signal from start to maximum positive, to maximum negative, and back to the starting position is called a cycle. *Table 1-1* shows how frequencies measured in cycles per second are converted into hertz, the common unit of measurement.

Frequency is measured in cycles-per-second and one cycle per second is called 1 hertz, named for the German scientist, Heinrich Hertz, credited with the discovery of electromagnetic waves. With our metal strip, we can vary the frequency at which it vibrates by lengthening or shortening the length of the piece of metal. The longer the metal strip, the longer the time it takes to vibrate through a complete cycle and the lower will be the frequency of the sound produced. Conversely, the shorter we make the strip, the shorter the time it takes to complete a cycle and the higher the frequency. At very high frequencies, we use terms such as kilohertz or megahertz for frequencies of thousands of cycles per second or millions of cycles per second, respectively. *Table 1-1* shows the conversion factors for kilohertz, megahertz, and gigahertz.

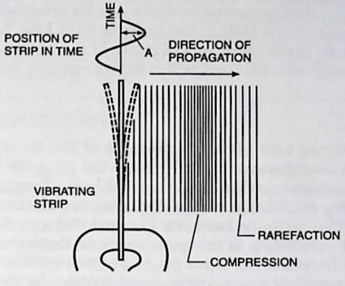
TABLE 1-1. Frequency conversion factors.

Cycles per second	Hertz	ABRV
1 =	1 cycle/second	(Hz)
10 =	10 cycles/sec	(Hz)
100 =	100 cycles/sec	(Hz)
1,000 =	1 kilohertz	(kHz)
1,000,000 =	1 megahertz	(MHz)
1,000,000,000 =	1 gigahertz	(GHz)

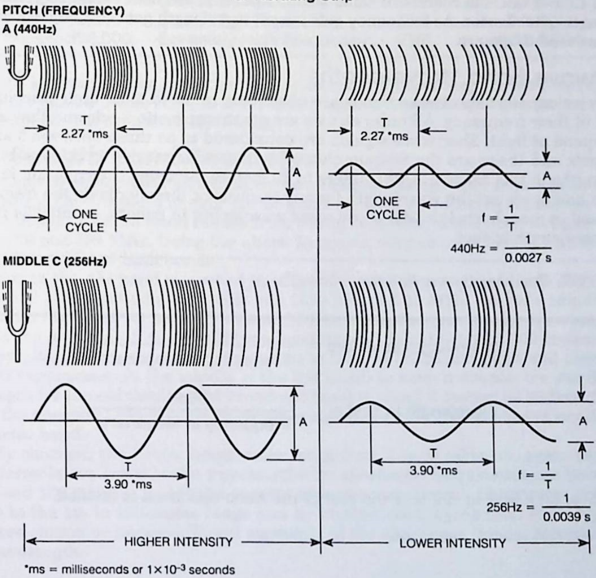
Notice from *Table 1-1* that when we use the abbreviations kHz and MHz, the first letter is not capitalized in kHz, but it is when we use MHz. Since Hertz is someone's name, the H should always be capitalized when used in abbreviations. In scientific and engineering discussions, the letter K, when printed in upper case, usually stands for Kelvin, a term used to express a measure of temperature; however, the lower-case k is used to represent 1,000 in general units of measure and stands for "kilo". The letter M also has different meanings, depending upon its use in print. A capital M stands for

FIGURE 1-3. Frequency.

Source: Electronics of Sound, *A.J. Evans, ©1990, Master Publishing, Inc.*



a. Vibrating Strip



b. Sound Waves with Different Frequencies and Intensities

"mega", as in millions, while a lower-case m stands for "milli", or one millionth! So, kilohertz is abbreviated kHz, while megahertz is abbreviated, MHz. One thousand megahertz is called one gigahertz, and is abbreviated GHz with a capital G for "giga".

Frequencies in the shortwave radio bands can be referred to in either kilohertz or megahertz. For example, 5.975 MHz is the same as 5975 kHz. Since there is a growing trend to use megahertz on the tuning dials of many of the newer shortwave radios, we will use megahertz throughout this book when listing specific frequencies or bands of frequencies.

Wavelength

The sounds shown in *Figure 1-3b* are at frequencies of 256 Hz and 440 Hz. *Figure 1-3a* and *1-3b* show how the sound waves move through the air, with the higher frequencies making waves that are closer together than those at lower frequencies. Radio waves can be pictured as moving in a similar way, except they are electromagnetic waves instead of air pressure waves. The distance between the peaks of a cycle, just like the water wave example we used previously, is the wavelength of the wave. As the frequency increases, the distance between the wave peaks decreases. Wavelength is the distance a cycle of the wave occupies in space as the wave travels. As the frequency increases, the less time it takes to reach the same relative point in the next cycle; therefore, the wavelength gets shorter. As frequency gets larger, wavelength gets smaller. Wavelengths are expressed in meters.

Shortwave Band Wavelengths

By convention, most shortwave bands are commonly referred to by their wavelength instead of their frequency. All radio signals are electromagnetic fields and they all travel at the speed of light. Shortwave signals are considered to be those between 3 and 30 megahertz and these are the frequencies we will concentrate on in this book. The wavelengths in this range are 100 meters to 10 meters. By using the equation in *Table 1-2*, you can work out the wavelength for any frequency. Simply divide the frequency expressed in megahertz into 300 if you want wavelength in meters, or into 984 if you want wavelength in feet.

TABLE 1-2. Frequency versus wavelength.

$$\text{Wavelength in Meters} = \frac{300}{\text{Frequency in Megahertz}}$$

$$\text{Wavelength in Feet} = \frac{984}{\text{Frequency in Megahertz}}$$

Now, let's look at the way the rest of the radio spectrum is divided.

The Radio Frequency Spectrum

The radio frequency spectrum is defined in *Table 1-3.* Radio frequencies below 0.03 MHz are called Very Low Frequencies, or VLF. The VHF (Very High Frequency) band ranges from 30 to 300 MHz. The UHF (Ultra High Frequency) band starts at 300 MHz and extends upwards to 3,000 MHz, or 3 gigahertz (GHz). We call the range between 3 and 30 GHz the SHF (Super High Frequency) band and from 30 to 300 GHz we have the EHF (Extremely High Frequency) band.

TABLE 1-3. Radio frequency bands.

Frequency MHz	Band	ABRV	Wavelength Meters
0.003-0.03	Very Low Frequency	VLF	100,000-10,000
0.03-0.3	Low Frequency	LF	10,000-1,000
0.3-3.0	Medium Frequency	MF	1,000-100
3.0-30	High Frequency	HF	100-10
30-300	Very High Frequency	VHF	10-1
300-3,000	Ultra High Frequency	UHF	1-0.1
3,000-30,000	Super High Frequency	SHF	0.1-0.01
30,000-300,000	Extremely High Frequency	EHF	0.01-0.001

At VLF frequencies, radio waves may be several miles long. In fact, wavelengths used by the United States Navy to send coded signals to submerged submarines are on the order of several thousand miles long.

Wavelength Band Examples

To put things in perspective, let's compare some familiar things with some not so familiar. The common AM-FM radio in your car or home (or pocket) receives signals on two separate bands. The AM band ranges from 550 to 1650 kHz, while the FM band runs between 88 and 108 MHz. Using the above formulas, we can calculate the wavelengths for, say, the middle of both bands.

Notice the AM band is marked in kHz (kilohertz). Converting kHz to MHz, we see that 550 kHz is actually 0.55 MHz and 1650 kHz is 1.65 MHz. So, let's simplify and say that the AM band is centered around 1 MHz. Using the formula for wavelength, we find that the wavelength of the AM broadcast band (1 MHz) is about 300 meters or 984 feet. Applying the same simple mathematics to the FM broadcast band and choosing 100 MHz (approximately the middle of the FM band) to keep it simple, we see that the wavelength for the old familiar FM broadcast band is about 3 meters or 10 feet. In other words, the common "AM-FM" radio receives signals in both the 300-meter band and in the 3-meter band.

By contrast, shortwave frequencies range from 3 to 30 MHz, so, again using our simple formula, we see that the wavelengths for shortwave frequencies are between 10 meters and 100 meters. And that's exactly how they are named. Shortwave stations operate in the 10- to 100-meter range and by international agreement each type of shortwave station occupies different segments of the shortwave bands, referred to by their wavelength.

Summary

In this chapter, we have discovered that shortwave radio signals exist between the AM and FM broadcast bands. The signals have been there all along and all you need to receive them is the right kind of radio.

As stated previously, although there are some differences, tuning in shortwave stations is very similar to tuning in your local AM and FM stations. You simply turn the dial until you hear something you like, or, if you know what you are looking for in the first place, you just tune to the specific frequency of the station you want. Many different kinds of shortwave receivers are available ranging from very simple and inexpensive to very complex and expensive, and you can be sure, there is one that is just right for you.

In the following chapters we will look at many of the different kinds of shortwave radio stations, where they are located on the shortwave bands and where they are located geographically as well. We will discuss how to tune in specific stations, how to identify new ones, and some of the available equipment for receiving them.

Where to Find Shortwave Signals

Introduction

As we have seen already, the shortwave radio bands lie between 3 MHz and 30 MHz. This is a fairly large portion of the radio spectrum and as you might expect, there is quite a lot of room for many stations. However, the radio spectrum is not unlimited and there are many different services and users vying for space to operate on the shortwave bands.

In order to coordinate and manage the radio frequency spectrum, the International Telecommunications Union (ITU) was established in 1865 for the purpose of developing regulations for the operation of telegraph lines. Today, the ITU decides how to allocate the limited radio spectrum among all the different users. Every few years, the member nations of the ITU meet to decide what changes need to be made as technological advances and increasing demand for radio frequencies make more efficient use of the spectrum more and more important. In February, 1992, the ITU held what is called the World Administrative Radio Conference for 1992, or, simply, "WARC-92".

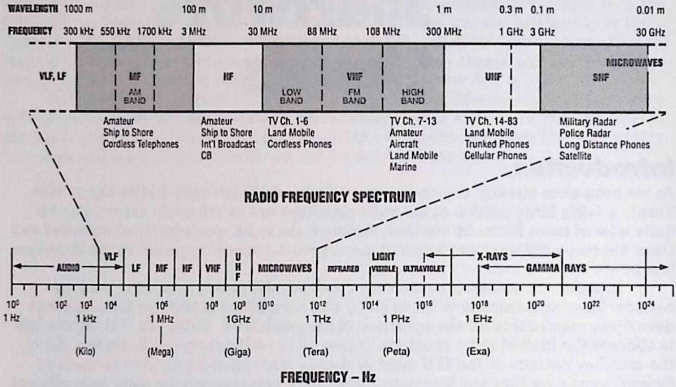
Among the different services competing for spectrum space are: commercial broadcast stations, commercial and private two-way radio users, governments, military services, maritime services and many others. At the end of each WARC, changes in the allocations of the shortwave and other radio frequency bands are incorporated into international treaties and each member nation must abide by these changes. Continuing advances in communications technology keeps the ITU busy from one WARC meeting to the next as new ways of communicating are continually being developed.

Figure 2-1 shows a representation of the entire electromagnetic spectrum from extremely low frequencies to extremely high frequencies. As you can see, the complete spectrum of electromagnetic energy extends well beyond radio waves. As we move higher in frequency, this form of radiation becomes microwaves, infrared radiation (felt as heat), visible light, ultraviolet light, X-rays and even Gamma rays.

Radio Spectrum

The radio spectrum is identified in the expanded portion of the electromagnetic spectrum of *Figure 2-1*. As stated in Chapter 1, the shortwave bands from 3 MHz to 30 MHz are referred to as the HF bands, meaning, High Frequency. Below the HF bands are the Medium Frequency (MF) and the Low Frequency (LF) bands. Above the HF bands are the Very-High-Frequency (VHF), the Ultra-High-Frequency (UHF), the Super-High-Frequency (SHF), and the Extremely-High-Frequency (EHF) bands. The radio spectrum from 2.3 MHz to 30 MHz is divided, as shown in *Table 2-1*, into segments that relate to

FIGURE 2-1. The electromagnetic spectrum detailing the radio frequency spectrum.
Courtesy FCC.
Source: Mobile 2-Way Radio Communications, G. *West,* ©*1993, Master Publishing, Inc.*



the approximate wavelength of each band. There are some European stations in the LF bands below 3 MHz (148.4 to 283.5 kHz) which are used similar to the AM band here in the U.S.A. The AM band in the United States is in the MF band from 550 kHz to 1650 kHz and many countries use this same allocation.

International Band Identification

The international broadcast bands are most commonly referred to by wavelength by shortwave listeners and broadcasters. For example, the frequency band from 5.950 MHz to 6.200 MHz is called "the 49-meter band". In fact, many shortwave radios have dials marked as indicated in *Table 2-1,* or have such markings on their band switches and tuning buttons.

Tropical Broadcast Stations

Amateur, military and "tropical broadcast" stations can be found above the standard AM broadcast band, in the MF band. The tropical broadcasting frequencies are allocated to countries located in the tropical zones. Less atmospheric noise is present on these frequencies in these geographic areas and signals from very high-power transmitters can usually be received up to 500 miles away. Tropical broadcasting extends into the HF bands to about 5.950 MHz. Some interesting communications can be heard on these frequencies! Nevertheless, the major activity for international broadcasts occur in the HF bands. Frequencies in between the bands shown in *Table 2-1* are used by military and government agencies as well as several other special services. We will discuss these in more detail later.

TABLE 2-1. International broadcast radio bands.

Band	Frequency
120 meters	2.300 - 2.500 MHz
90 meters	3.200 - 3.400 MHz
75 meters	3.750 - 4.000 MHz
60 meters	4.750 - 5.050 MHz
49 meters	5.950 - 6.200 MHz
41 meters	7.100 - 7.300 MHz
31 meters	9.500 - 9.900 MHz
25 meters	11.650 - 12.050 MHz
21 meters	13.600 - 13.800 MHz
19 meters	15.100 - 15.600 MHz
16 meters	17.550 - 17.900 MHz
13 meters	21.450 - 21.850 MHz

Tuning In

Shortwave broadcasting is very much like the familiar AM-FM broadcasting you hear on your home, car or portable radio. You listen to your favorite AM or FM stations almost daily as you work and play and go about your daily routines. We even take it for granted that these stations will be there when we turn on the radio. But how did you find your "favorite station" in the first place?

Although we see advertisements for different radio stations on billboards and on television, most people simply turn the dial on their AM-FM radio until they hear something they like. You can find shortwave stations like that too. However, there are some big differences between local radio stations and international broadcast stations. For one thing, the local stations are always "loud and clear" when you turn on your radio. Foreign radio stations, on the other hand, may be have a strong signal at one time and be too weak to hear at another. As we will see later, this variation is caused by the very same atmospheric conditions that permit radio signals to travel around the world in the first place. But the conditions vary considerably, depending mainly on the time of day and several other factors we will discuss in detail later. In order to overcome this problem of changing conditions, international broadcasters use several different frequencies simultaneously or switch from one frequency to another, depending upon the time of day, in order for their signals to reach their intended audiences.

In order to find a shortwave broadcasting station, you could simply start tuning around until you hear a station. As a matter of fact, this method is one of the most interesting ways of exploring the shortwave bands. You never know what you might find. And with the very wide variety and different types of stations on the shortwave bands, you will always find something unusual. This is a lot like fishing. You never know what you might catch. The excitement of hauling in that "big one" lures many fishermen back to the lake weekend after weekend. Catching a rare, exotic or unusual shortwave radio signal can be equally compelling.

Getting Started

To get you started, here are several specific stations where you can often find a broadcast. The BBC can usually be heard on 9.410, 12.040, and 15.070 MHz. As this chapter was being written, your author found the BBC loud and clear on 5.975 MHz around midnight,

local time. The two announcers were discussing international news stories. Turning the dial slightly (actually in this case, the "up" button was just touched) Radio Austria International was even stronger at 6.015 MHz. The Voice of America (VOA) was easy to find at 6.035 MHz. All of these programs were in English and all were discussing world events, including details of stories that the local television "news-at-10" only touched on, if they mentioned them at all.

Listening to the VOA, they announced that they were ending their European programs on several frequencies at that particular time and announced the frequencies to which they were switching. Since these stations intend for you to hear their signals, they make it easy to keep up with them when they change operating frequencies with the time of day or night to compensate for changing band conditions.

With many of the newest models of shortwave radios, you can make the radio "scan" for a strong signal. You select a starting point and then press the "up" or "down" button and the radio will start searching in the direction you selected. When it finds a station, it stops on that frequency. So even if you don't have any notion of what you're looking for, you can let the radio itself find something. And if that station turns out to be boring or in some foreign language you can't understand, just hit the "up" button again and see what turns up next!

Using Frequency Lists

Another way of finding shortwave broadcast stations is to use a frequency list. Many good books are available which list hundreds of stations operating on the shortwave bands, including their frequency, daily operating schedule and even their program content. There are also several periodicals devoted to shortwave radio which often carry feature articles on specific stations.

Two of the most popular monthly magazines devoted to shortwave radio are "POPULAR COMMUNICATIONS," edited by Tom Kneitel and published by CQ Communications, Inc., Hicksville, New York, and "MONITORING TIMES," edited by Bob Grove and published by Grove Enterprises, Brasstown, New Jersey. Both of these can be found at your local bookstore. Both of these periodicals cover VHF and UHF frequencies as well as the shortwave bands and have a good balance between all the various types of communications services covered. Both editors are licensed amateur operators as are many of their staff. Their interest and experience in the hobby make these publications well worthwhile, and you can learn a lot as each month both of these magazines are filled with new feature articles on past, present and future happenings in the world of communications. There even are monthly world-band frequency lists to keep you updated on the latest changes in international broadcasting.

With a list of frequencies in hand, you can find the exact frequency that a shortwave broadcaster will be using at any particular time. Since they all use Universal Coordinated Time, most lists are easy to use. Use the time conversion guide in Chapter Three to convert your local time to UTC time and then just dial in (or key in) the frequency of the station you want on your world band radio and, if conditions are right, you should hear that station.

Radio Wave Propagation

We mentioned that shortwave broadcasters may operate on more than one frequency at a time or change frequencies depending upon the time of day. The reason for this is due to something called propagation. Propagation refers to how shortwave signals are affected by atmospheric conditions which cause the signals to vary from strong to weak in a particular location. This "fading" is caused by changes in the ionosphere where

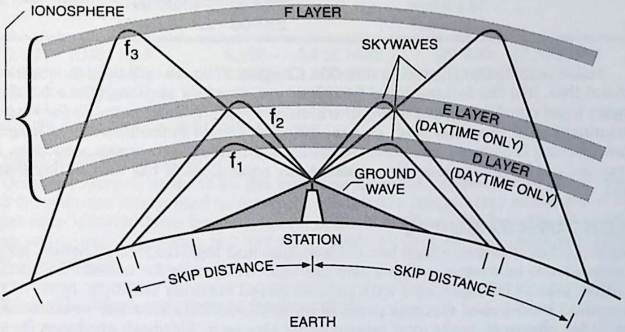
layers of ionized gases are concentrated. As shown in *Figure 2-2*, radio signals are reflected (called sky waves) by these regions of ionized gases whose composition, altitude and shape all change constantly, due to the heating and cooling of the atmosphere associated with day and night. The ionosphere is also affected by solar flares (called sun spots) on the surface of the sun. It is the sun's radiation that causes the ionization of our atmosphere in the first place.

Ground and Sky Waves

Radio signals also travel along the surface of the earth and some "bending" does occur which allows these signals to be received beyond the horizon. However, signals received from over the horizon are usually signals that were reflected off the ionosphere. This is often called "skip" due to the fact that these signals seem to skip over great distances as they travel around the globe. It is this reflecting of radio waves off the ionosphere that permits us to hear signals from very far over the horizon and even from the other side of the world. *Figure 2-2* shows both direct (ground wave) and reflected (sky wave) radio signals and how changing conditions affect reception.

FIGURE 2-2. Radio wave propagation.

Source: Mobile 2-Way Radio Communications, G. *West*, ©1993, *Master Publishing, Inc.*



Variation with Frequency

The altitude of these reflective layers in the Earth's atmosphere greatly affects how much bending occurs when radio signals reach these layers. The different frequencies that are reflected are bounced back toward the ground at different angles and even different intensities. Some layers, such as the D and E layers shown in *Figure 2-2*, which are present in the daytime, absorb signals below about 7 MHz. Frequencies in the higher end of the HF band tend to be reflected almost 100 percent, while frequencies in the VHF-and-above ranges are rarely reflected at all. Since shortwave broadcasters must rely on the ionosphere to bounce their signals over the horizon to their intended audiences, and since different frequencies are reflected at different angles, most broadcasters use several different frequencies at a time, or change frequencies, depending upon the time of day, to compensate for these changes in propagation.

In general, radio signal reception in different portions of the shortwave bands tends to follow the daytime-nighttime cycle and shortwave radio stations take advantage of this by using the most favorable frequencies for their operating schedules.

Amateur Service Bands

Amateur bands, like shortwave broadcast bands, are also commonly referred to by their wavelengths. *Table 2-2* lists the international shortwave bands allocated to the amateur service and the corresponding frequencies.

TABLE 2-2. International amateur service bands.

Band	Frequency
160 meters	1.800 - 2.000 MHz
80 meters	3.500 - 4.000 MHz
40 meters	7.000 - 7.300 MHz
30 meters	10.100 - 10.150 Mhz
20 meters	14.000 - 14.350 MHz
17 meters	18.068 - 18.168 MHz
15 meters	21.000 - 21.459 MHz
12 meters	24.890 - 24.990 MHz
10 meters	28.000 - 29.700 MHz

Amateur Radio is covered in detail in Chapter 6, so we will only mention at this point that, like the international broadcasters, amateur stations take advantage of changing band conditions by moving to whichever band is most suitable for long range communications at the time. With several different bands in the shortwave range, the amateur service is assured of almost continuous, worldwide coverage, and thus, is able to serve the public during emergency situations regardless of the time of day they are needed.

Aeronautical Bands

Among the other services which use the medium- and high-frequency bands, airliners and cargo planes on overseas flights also use shortwave radio for communications, both with other planes in flight, and with ground-based stations en route. Most of the aeronautical land-based stations provide up-to-the-minute weather conditions and forecasts for planes en route over international airspace. Although airplanes fly very high, the VHF and UHF radios they use over the continental United States and other countries around the world simply do not carry much farther than the "radio horizon". In order to maintain contact with air traffic controllers and their own companies, international flights use what are called the Aeronautical Mobile bands and these are listed in *Table 2-3.* On these frequencies, you can hear flight clearances being given, course changes, en route weather forecasts, even passenger lists and cargo manifests being transmitted.

Maritime Bands

Like airplanes on overseas flights, ships at sea use shortwave radio to keep in touch with each other and with both their home ports and destination ports of call. Recent changes in technology and even economics have made an impact on the maritime service.

TABLE 2-3. International aeronautical frequencies.

2.850 - 3.150 MHz	8.815 - 9.040 MHz	15.010 - 15.100 MHz
3.400 - 3.500 MHz	10.005 - 10.100 MHz	17.900 - 18.030 MHz
4.650 - 4.750 MHz	11.175 - 11.400 MHz	
6.525 - 6.765 MHz	13.200 - 13.360 MHz	

In past years, each ship on the open seas was required to have a radio operator aboard who could not only operate the radio equipment, but repair it as well. "Sparks" is the nickname for a ship's radio officer and the moniker comes from the bygone days when the International Morse Code was the primary means of communications on the open seas. Today, the radio operator is almost no longer necessary, being gradually replaced by modern computer-driven, satellite-tracking communications systems that not only provide two-way radio contact, but precision navigation as well. *Table 2-4* shows the Maritime Mobile Service frequencies between 3 and 30 MHz. Below 3 MHz, in the band from 2 MHz to 3 MHz, there are many communications which cover several hundred miles.

TABLE 2-4. Maritime shortwave bands.

2.000 - 2.850 MHz	8.195 - 8.815 MHz	22.000 - 22.855 MHz
4.063 - 4.438 MHz	12.330 - 13.200 MHz	25.100 - 25.550 MHz*
6.200 - 6.765 MHz	18.755 - 19.797 MHz	

**Shared with Fixed and Land Mobile stations*

Emergency and Distress

While there is plenty to listen to on the maritime bands in general, there are several specific frequencies designated as maritime emergency frequencies and ships at sea are required to monitor these frequencies for ships in distress. The primary international maritime emergency frequency is 2.182 MHz. *Table 2-5* lists each of these international distress frequencies.

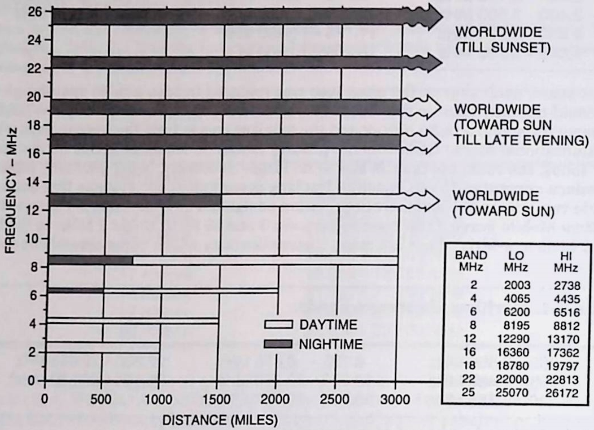
TABLE 2-5. Maritime emergency frequencies.

2.182 MHz	6.215 MHz	12.290 MHz
4.125 MHz	8.281 MHz	16.420 MHz

Because of the vast distances ocean-going vessels travel on the open seas, it is important for them to be able to communicate on many different frequencies in order to take advantage of the conditions at any particular time of day. *Figure 2-3* shows the relationship between distance and frequency and time of day for ships at sea. This chart can also be useful for determining radio range for land mobile communications and other services.

FIGURE 2-3. Marine SSB frequency assignments and approximate range of transmission.

Source: Mobile 2-Way Radio Communications, *G. West, ©1993, Master Publishing, Inc.*



Fax Frequencies

Modern communications equipment allows transmission of weather satellite photographs and maps and other printed documents using facsimile equipment just like in most business offices. These are especially useful to commercial vessels including both passenger liners and cargo ships. *Table 2-6* lists frequencies designated for transmission of facsimiles (FAXes). Several companies make equipment that attaches as an accessory to a receiver capable of receiving these maritime FAX signals.

TABLE 2-6. Maritime fax frequencies (Ship-to-shore).

2.0705 MHz	2.0725 MHz	2.0745 MHz
2.0765 MHz	4.1545 MHz	4.1695 MHz
6.2355 MHz	6.2595 MHz	8.3025 MHz
12.3750 MHz	12.4185 MHz	16.5515 MHz
16.6145 MHz	18.8475 MHz	18.8685 MHz
22.1815 MHz	22.2385 MHz	25.1235 MHz

Fixed Service Bands

As the name implies, Fixed Service stations are ground-based stations operating from fixed sites. There are many different types of fixed station operations, many of which today use digital communication techniques such as radioteletype (RTTY). Computer programs and interface devices are available to connect your shortwave receiver and computer so that you can see what's being sent by all those strange sounds you hear from these stations.

Such intriguing organizations as INTERPOL, the International Police Organization, the United States Federal Bureau of Investigation and the Central Intelligence Agency operate fixed service stations all over the world. Although not as easy to find (they don't transmit continuously, for one thing) these can be very interesting when you do hear them. Other types of fixed stations transmit almost endless strings of seemingly random letters and numbers. Many avid DXers are convinced that the signals are intended for spies in the field and many amateur cryptologists find it interesting to apply decryption analysis to these signals looking for hidden messages. *Table 2-7* lists the frequencies allocated to the Fixed Service.

TABLE 2-7. Bands allocated to the fixed services.

5.005 - 5.450 MHz	13.800 - 14.000 MHz
5.735 - 5.950 MHz	14.350 - 14.490 MHz
6.765 - 7.000 MHz	15.600 - 16.460 MHz
7.300 - 8.195 MHz	17.360 - 17.550 MHz
9.040 - 9.500 MHz	18.030 - 18.068 MHz
9.900 - 9.995 MHz	18.168 - 19.990 MHz
10.150 - 11.175 MHz	20.010 - 21.000 MHz
11.400 - 11.650 MHz	22.855 - 23.200 MHz
11.975 - 12.330 MHz	25.010 - 25.550 MHz
13.360 - 13.600 MHz	26.100 - 28.000 MHz

Citizens Band

The Class D Citizens Band is allocated 26.965 MHz to 27.405 MHz. In the early days of "CB", these frequencies were populated by short-range AM conversations between citizens using CB for everything from traffic reports (usually "Smokey reports", referring to the location of police looking for speeders) to farming and small business activities. Without serious licensing requirements, and with the discovery by many CBers that signals in the 27 MHz range could be "skipped" across the country, the Citizens Band became overpopulated and unmanageable by the FCC. Later expansion of this band permitted SSB transmissions and this mode of communication enhanced communications range even farther. Today, the band has settled down somewhat from its heyday. You can pick up CB signals on most shortwave receivers, but be forewarned that you might run across some offensive language in this band, and even outright arguments between rivals trying to chase each other off "their" frequency.

Now that the FCC has dropped the Morse code requirement for obtaining an amateur operator's license, many CBers have left this band in favor of the more rewarding conversations to be had on the amateur service bands. International treaties still require Morse code proficiency to operate on HF bands, but new Technician Class No-Code

amateur operator licensees may use voice mode radios on all of the VHF and UHF bands for Amateur Radio.

Military and Space Communications

Many other very interesting signals can be heard in between the allocated bands described above. Military units around the world depend upon shortwave radio for much of their communications, both in the field and with their command centers. When the President of the United States flies, his aircraft is given the call sign, "AIR FORCE ONE" and many of Air Force One's communications are carried out on such frequencies as 17.385 MHz and 6.685 MHz. Even NASA's Space Shuttle operations can be heard on shortwave as their global network goes through preparations for launch. Live audio communications between the astronauts and ground controllers continues through each space flight from before blast off until after touchdown. *Table 2-8* lists several frequencies used for space shuttle missions. Some of these are being phased out as NASA communications facilities are moving towards more use of UHF voice band satellites for routine flights.

TABLE 2-8. NASA space shuttle support activities on shortwave frequencies.

2.678 MHz	7.765 MHz	9.131 MHz	15.015 MHz
3.860 MHz	8.893 MHz	10.780 MHz	18.200 MHz
5.810 MHz	8.972 MHz	11.407 MHz	20.192 MHz
6.693 MHz	9.981 MHz	13.170 MHz	20.197 MHz
6.938 MHz	9.043 MHz	13.213 MHz	20.390 MHz

The FCC has granted permission for stations using Amateur Radio to relay live NASA shuttle mission audio and television on the ham bands. In most areas of the country you can hear these amateur relay stations on both shortwave and VHF-UHF bands. *Table 2-9* lists several popular shortwave frequencies used for these transmissions.

TABLE 2-9. Amateur relay frequencies of shuttle missions.

3.860 MHz	14.285 MHz	21.390 MHz
7.185 MHz	14.295 MHz	28.650 MHz

If you are lucky enough to be in Washington DC (anywhere near Greenbelt, Maryland, actually) you can get *EASY LISTENING* on a VHF scanner on 145.55 and 147.45 MHz. In Los Angeles, mission audio is often piped out on 224.04 MHz direct from the Jet Propulsion Lab in Pasadena and several repeaters such as 145.6 MHz, 145.46 MHz, 146.75 MHz, 446.775 MHz, and 447.775 MHz often provide real-time monitoring as well. In the Fort Worth-Dallas area, shuttle mission audio can be heard on 448.75 MHz being relayed from the University of Texas at Arlington campus.

Additional frequencies you might check include those shown in *Table 2-10*. Several NASA communications networks are moving to UHF and satellite-relayed circuits; however, several shortwave frequencies are still used before, during and immediately after most space shuttle missions for both primary and alternate communications. Tune your radio to these frequencies for some interesting listening.

TABLE 2-10. Space shuttle communications on shortwave.

2.664 MHz	Backup mission audio (Cape-to-Houston)
3.024 MHz	Primary Coast Guard SAR/Recovery Channel
6.720 MHz	Primary SAR Atlantic Fleet
7.525 MHz	NASA Ground Tracking Net
19.64 MHz	Cape Radio
20.186 MHz	Launch Tracking Net
23.413 MHz	Cape Radio

Miscellaneous

Many other services can be found in between the international broadcasters. The Forestry Service, the FAA and even the FCC. Illegal broadcasters, called "clandestine" stations can be heard, along with customs agents, drug enforcement agents, and all manner of military and paramilitary operations. Whenever the routine rhetoric and political propaganda becomes boring, just a few turns of the dial away you can find a whole new adventure just waiting for you.

Listening In

The following is a potpourri of interesting frequencies to get you started on listening in on the shortwave bands. These frequencies were selected at random from *THE D/FW FREQUENCY LIST* published by Basic Computer Services Company, Arlington, Texas, available through Tandy's Outlet Store, 1717 North Park Drive, Fort Worth, Texas 76102. Frequencies shown in *Table 2-11* include frequencies used by hurricane hunter aircraft and ham radio "nets" operated for discussing shortwave listening. Many hams got their start in Amateur Radio by first listening to shortwave signals and they still enjoy that activity so much that they hold on-the-air meetings called "nets" to discuss shortwave listening specifically. Tuning in on these round-table discussions can provide a wealth of information for any shortwave listener.

TABLE 2-11. Selected frequencies to explore.

Frequency	Remarks
3.910 MHz	Central Texas Emergency Nets (Amateur)
3.925 MHz	Hurricane Hunters (Amateur)
3.955 MHz	South Texas Emergency Nets (Amateur)
4.235 MHz	Hurricane Hunters (CAP Aircraft, Fixed)
4.467 MHz	Hurricane Hunters (CAP Aircraft, Fixed)
6.507 MHz	Hurricane Hunters (CAP Aircraft, Fixed)
7.240 MHz	Amateur SWL Nets, Sundays at 10:00AM
8.494 MHz	Maritime Fixed Station, Adak, Alaska
8.617 MHz	Maritime FAX transmissions
8.709 MHz	Maritime CW transmissions
13.114 MHz	Maritime Fixed Station, Adak, Alaska
14.313 MHz	Maritime Fixed Station, (prime listening)
14.325 MHz	Maritime Fixed Station, (prime listening)

Radio Monitoring Laws

By the way, you should know that there are some restrictions on listening in on certain types of communications. There are two articles of legislation enacted by the United States government that place limitations on radio monitoring. The Communications Act of 1934 makes it illegal to divulge the contents of some radio communications, or to use information gained in such manner for personal or financial gain. No one ever objected too strongly against that particular law, but in 1982, Presidential Executive Order 12356 reclassified the government master file of radio frequencies from Unclassified to Confidential, and, therefore, unavailable to the general public. Not even the Freedom of Information Act can be invoked to gain access to this information. And in 1986, the Electronic Communications Privacy Act was passed, over strong objections, to restrict (at least in law) the monitoring of selected radio signals such as cellular mobile telephone radio calls. While this law does prohibit intentional eavesdropping on some types of radio telephone conversations, it does specifically allow public reception of other communications.

It is generally accepted by communications experts that any real level of security using any type of radio transmission is the responsibility of the sender. Laws such as these are difficult to enforce, to say the least. And since even older model television sets are quite capable of tuning in cellular telephone conversations, it would be hard to prosecute anyone for violating such laws. Common sense should be your guide. It is one thing to listen in for personal enjoyment and quite another to use someone else's personal conversations for illicit gain.

Summary

Few hobbies offer the variety that listening to shortwave does. Where else can you find excitement, intrigue, entertainment, education, mystery, and romance all in one place? And it's there waiting for you whenever you're ready. As the world turns, something interesting is happening somewhere every minute of the day or night. No matter what time you choose to relax with your world band radio, sounds and music from exotic, faraway lands beckon. Mysterious signals suggest conspiracy and stir the imagination. World-wide news stories are discussed in detail and you can listen in as real-life dramas unfold.

There are shortwave receivers for every pocket book and for every level of interest, from casual listening to serious monitoring. You can listen at home, in your car or on the beach. Whether you take a portable radio with you as you go or build your own global communications center or "radio shack", listening to shortwave will provide many hours of fun and enjoyment for many years to come. Listening to shortwave is an extraordinary experience.

What Am I Listening To?

English Language Broadcasts

As you tune across the shortwave bands, you will find quite an assortment of different signals and strange sounds. Some of them will be easy to tune in, recognize, and understand, such as the Voice of America (VOA), the British Broadcasting Corporation (BBC) or Radio Moscow. Many countries transmit daily programs in the English language and beam their signals directly at the United States. And as we mentioned earlier, many of these stations transmit on more than one frequency at a time so that if conditions on one band are poor, chances are another band will be favorable for good reception. These stations are easy to find because they want you to find them. They use directional antennas and vast amounts of power in order for you to be able to hear them.

Foreign Language Broadcasts

Shortwave broadcasts in languages other than English are abundant, and if you are trying to learn a foreign language, listening to foreign broadcasts can be very rewarding. Not only do you get an accurate rendition of the native language as spoken in that country, but you also get a feel for the culture and traditions that is impossible to find without actually being there. Several stations schedule selected programs specifically for such listeners, and the speakers intentionally talk very distinctly, pronouncing each word separately for better understanding. Listening to a foreign broadcast adds color and richness to learning about other lands.

Music

Music from faraway places is often exotic and intriguing, bringing you even closer to the cultures and customs of peoples from all over the world. With music, you do not have to know the native tongue to enjoy the program. Oftentimes the music and entertainment programs from distant lands include materials especially aimed at shortwave listeners and includes a little history or geography of the country. If you understand the language, you not only get entertained, but you learn something new as well.

News and Information— Take Some with a Grain of Salt

The Voice of America and the BBC are excellent sources of world news. Most events are reported in much more detail than what you see on television, hear on local radio stations, or read in your local newspaper. For one thing, the pace is much slower and

the commentators are not being rushed by their directors to get the point across in time for commercials. In fact, very few commercials are even heard on the shortwave bands; another fun reason for listening to shortwave.

You can also find stations obviously under the control of dictators and ruthless governments that are dedicated to filling the airwaves with their own views on both internal and world events. Propaganda broadcasts are often obvious when you find them. These stations seem bent on convincing the world that their governments are being treated unfairly or that the United States or some other democratic country is evil and imperialistic. At first, you may find such broadcasts offensive. But after you listen awhile they sound silly and inept. Their outlandish tirades are so obviously one-sided that you realize the only ones who might believe them are themselves.

Of course, there are varying degrees of propaganda and many broadcasters are influenced to one degree or another by their respective countries. Most of these stations operate by the authority of their own governments and it is not unusual that many shortwave broadcast stations are government-operated or, at least, use considerable discretion when covering stories which might embarrass their benefactors.

But what are all those other signals that pervade the short-wave bands? As you tune your world band receiver in between the international broadcast bands listed back in *Table 2-1*, you will find all sorts of strange sounds. Some sound like crickets chirping; others sound like machine guns clattering, others like whistles, pops and continuous warbling musical notes rising and falling. In the next few paragraphs, we will look at some of these strange signals and identify several of them.

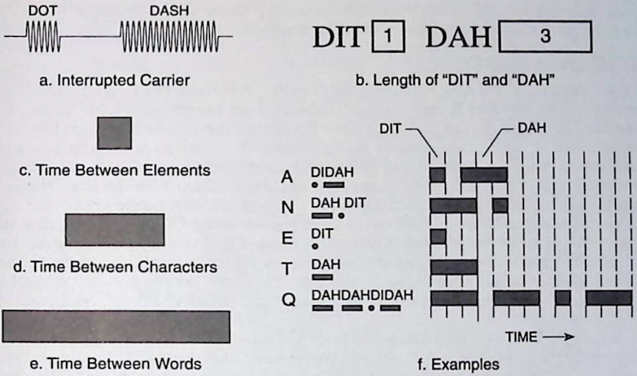
Morse Code

The first commercial form of radio communications was continuous wave (CW) signals using a code invented by Samuel F.B. Morse, 1791-1872. Morse was an artist and inventor who promoted the use of the telegraph during its early development. Using a series of short (dot) and long (dash) sounds to represent the 26 letters, 10 numerals and a few punctuation marks, Morse code can be sent over telegraph wires or radio waves. Examples are shown in *Figure 3-1*. On the radio, CW signals often can be copied under conditions when most other modes of communications are useless.

Today, automatic digital signal processing and error-correcting codes are gaining acceptance worldwide. Recently, the FCC even removed the Morse code requirement from licensing tests for certain amateur operator classes. Nevertheless, many proponents argue that Morse code will be around for a long, long time to come. In the shortwave bands, International Morse signals can be found everywhere, giving credence to those claims.

Many who enjoy using Morse code can easily copy such signals at speeds of up to 80 words per minute. Using many abbreviations and special "Q-signals" for often-used words and phrases makes sending and receiving Morse code even easier. And even though there are many who consider it a lot of trouble to learn, kids as young as 5 and as old as 80 have mastered it. Boy Scouts learn it for merit badges and survivalists memorize the Morse code in a matter of hours. Once you know it, you'll never forget it and as for learning a new "language", it's the easiest one by far! With a little patience and practice, you can learn to "copy" CW signals on the shortwave bands and discover an entirely different mode of communications. Amateur, military and fixed stations use CW. You'll hear ships at sea, airplanes and clandestine stations using Morse code. Learn it with a friend and you'll be able to communicate with each other "secretly"; even in a crowd!

FIGURE 3-1. Morse code uses short and long time bursts of CW to identify letters, numbers, punctuation marks, and special characters.



Digital Communications

Some of the strange noises you will hear on the shortwave bands are digital communications signals. Digital signals carry simple text, data, or even high-resolution photographs. There are several different methods currently being used around the world to transmit information using radio. Weather satellites and military satellites alike convert the photographs taken while orbiting the earth into digital form before they transmit them to ground stations. The military "spy" satellites use various modulation and encryption techniques, however, many of the weather satellites transmit their photos to earth stations in a form that can be decoded by equipment you can purchase that attaches directly to your shortwave receiver. Some of these devices use their own printer while others use any standard personal computer printer. Using these devices, you can print your own satellite photographs! The images can be displayed on your computer screen, and, using currently available software, you can zoom in for close-up images and make your own prints.

Many of the earth stations that receive the signals turn around and retransmit these photographs to other stations around the world. In the case of military reconnaissance satellites, the signals are encrypted using extremely complex coding schemes in order to thwart anyone attempting to decode their sensitive pictures.

It is interesting to note that, according to current information available on the state of the art in satellite photography, that some military satellites can take pictures of people and their surroundings on the ground with such high resolution that you can tell the difference between men and women, and read license plate numbers on cars and trucks. When you tune in these signals on your shortwave receiver, they have a number of different sounds, depending upon the type of encoding in use and the speed at which they are sending their data. Lower data rates sound like a pair of tones alternating with each other while the higher data rates sound like high-pressure steam escaping.

Radioteleprinter Signals

Other strange sounds can be attributed to some of the various "radioteleprinter" codes being used. Recent advances in computer technology have provided communications systems that can actually guarantee 100% accuracy under any conditions when transmitting messages using some of the latest techniques.

SITOR and AMTOR

One such method of sending messages on shortwave is called SITOR (Synchronous Information Transfer Over Radio) and AMTOR (Amateur Teleprinting Over Radio). These two systems are very similar and each uses the technique of sending short bursts of a few characters at a time then waiting for the receiving station to acknowledge receiving the characters correctly. AMTOR and SITOR allow automatic error detection by comparing the received data with a calculated numerical value sent along with the text. The sending station makes a mathematical calculation based upon the characters being sent and includes the results of that calculation in each transmission. When the receiving station gets the data, it performs its own calculation (called a checksum) based upon the characters received. The receiving station then transmits an "acknowledgment" back to the originator where the two checksums are compared. If they are the same, it is assumed that the group of characters was received correctly and the next group of characters is sent.

On shortwave, stations using this form of communication are easy to find due to the distinct impression you get of signals being sent "back-and-forth" between two stations. The exchange between the two stations occurs very quickly and when tuned in with a shortwave receiver, these signals sound like crickets chirping. With the appropriate accessory device attached to your receiver, you can copy these signals and display the text of their messages on your computer or terminal screen or printer. Several manufacturers provide such equipment and some are available which provide the hobbyist with a choice of up to six or seven different digital modes, including PACKET, RTTY, AMTOR, FAX, and CW.

Radio Teletypewriter (RTTY) Signals

Another type of digital signal used by a *Teletype®* machine, though older, is still very much in use. RTTY, as it is called, uses the *Baudot* code and equipment called teleprinters to send and receive text. The term "RTTY" found in most shortwave guides and frequency lists stands for Radio TeleTYpewriter. RTTY signals can be recognized by their distinctive sound—a steady audio signal alternating between two distinct tones at a very fast rate. RTTY stations can be found throughout the shortwave bands sending data at rates of 45, 50, 60, 80 and 100 words per minute.

The Baudot code used in RTTY contains only 5 bits, so only numbers and upper-case letters can be sent using this method. The Baudot code sends text over the radio by rapidly switching back and forth between two tones, called mark and space. Text sent over the radio in Baudot code uses two distinct audio tones, which are alternated in a specific pattern for each character. It is this rapid shifting between the higher and lower tones that gives RTTY its distinctive sound. With the rapid growth of computer-controlled communications, RTTY is slowly but surely losing ground, but there will be many stations using it for several years. RTTY equipment is impressive. An early Telex® machine is shown in *Figure 3-2*. If you've ever seen a Telex machine running, you know what RTTY looks and sounds like, at least from a mechanical point of view.

FIGURE 3-2. Teletype machines make characteristic sounds as they operate.
Courtesy of Telephone Pioneer Museum.

Utility Stations

Time and Frequency

Have you ever wanted to set your watch or clock to the *exact* time? We mean *absolutely, positively the exact* time! Well, in fact, there are several radio stations that are *dedicated* to providing the correct time right down to several millionths of a second. The National Institute of Standards and Technology (it used to be the National Bureau of Standards) operates such a radio station—WWV in Fort Collins, Colorado—broadcasting standard time signals continuously on 5, 10, 15 and 20 MHz.

When you tune in WWV you will hear either a steady carrier or one with a steady tone, interrupted each second by a "tick". Several seconds before the top of the minute, a voice announcement will say, for example: "At the tone, three hours, fifteen minutes, coordinated universal time." Time is given in 24-hour format, based up Coordinated Universal Time (UTC) at Greenwich, England. Not only are these time marks extremely accurate, but so are the radio frequencies that are used to carry the standard time signals. Simultaneously, the NIST operates transmitters in both Colorado and Kauai, Hawaii. The Hawaii station call sign is WWVH. The signals are so perfectly synchronized that you can often hear both locations at the same time, without interference. It sounds like one is just a little weaker than the other.

Other nations also operate standard time and frequency stations. Several of these are listed in *Table 3-1*. Such ultra-accurate stations provide a valuable service for communications and all sorts of other facilities over the world. For example, television stations use these signals to fine-tune their instruments, as well as to keep their clocks synchronized.

TABLE 3-1. Standard time and frequency stations.

Frequency	Call	Location
2.500 MHz	WWVH	Fort Collins, Colorado
2.500 MHz	WWVH	Kauai, Hawaii
3.330 MHz	CHU	Ottawa, Ontario, Canada
5.000 MHz	WWV	Fort Collins, Colorado
5.000 MHz	WWVH	Kauai, Hawaii
7.335 MHz	CHU	Ottawa, Ontario, Canada
8.000 MHz	JJY	Tokyo, Japan
10.00 MHz	WWV	Fort Collins, Colorado
10.00 MHz	WWVH	Kauai, Hawaii
10.00 MHz	BPM	Xian, China
10.00 MHz	JJY	Tokyo, Japan
10.00 MHz	LOL	Buenos Aires, Argentina

UTC-Coordinated Universal Time

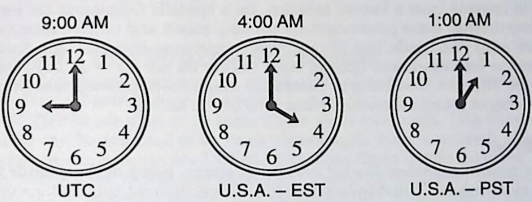
Table 3-2 shows the relationship between the time zones across the continental United States and Coordinated Universal Time (UTC). The numbers represent the time in the

TABLE 3-2. Time conversion UTC related to U.S.A. time zones.

UTC	AST/EDT	EST/CDT	CST/MDT	MST/PDT	PST
0000	2000	1900	1800	1700	1600
0100	2100	2000	1900	1800	1700
0200	2200	2100	2000	1900	1800
0300	2300	2200	2100	2000	1900
0400	0000	2300	2200	2100	2000
0500	0100	0000	2300	2200	2100
0600	0200	0100	0000	2300	2200
0700	0300	0200	0100	0000	2300
0800	0400	0300	0200	0100	0000
0900	0500	0400	0300	0200	0100
1000	0600	0500	0400	0300	0200
1100	0700	0600	0500	0400	0300
1200	0800	0700	0600	0500	0400
1300	0900	1800	0700	0600	0500
1400	1000	0900	0800	0700	0600
1500	1100	1000	0900	0800	0700
1600	1200	1100	1000	0900	0800
1700	1300	1200	1100	1000	0900
1800	1400	1300	1200	1100	1000
1900	1500	1400	1300	1200	1100
2000	1600	1500	1400	1300	1200
2100	1700	1600	1500	1400	1300
2200	1800	1700	1600	1500	1400
2300	1900	1800	1700	1600	1500

standard 24-hour format used by military and law enforcement agencies around the world. An example is shown in *Figure 3-3*. Airlines and most organizations that use international communications also use UTC time. Although local agencies such as police and fire departments use a 24-hour time format, they do so based on their own local area time. If you hear the local police dispatcher say that the time is "thirteen hundred hours", it means the time is 1 p.m. "Fourteen-twenty" means 2:20 p.m. On the shortwave bands, you will hear ham operators, military stations and commercial stations use a phrase like, "fifteen hundred Zulu". When the letter Z or the word Zulu is used following the time, it is the time expressed in UTC or "Universal Time."

FIGURE 3-3. UTC time is eight hours ahead of Pacific Standard Time.



Emergency Frequencies

Monitoring the various emergency frequencies can be a great hobby in itself. Within the bands we have covered so far, there are several designated emergency frequencies for many of the different services. Concentrating on a police, fire, aeronautical, or maritime band can be exciting monitoring.

Spy Radio

Does the intrigue of catching spies and saboteurs interest you? If so, you can spend many hours enjoying the excitement of listening for these rare stations. You probably will not hear "Broadshort calling Danny Boy" (from the movie "Where Eagles Dare"[1], with Richard Burton, et.al.), but who knows? Real spies use codes and ciphers. They often use secret transmitters that run on batteries and therefore produce fairly weak signals. In order to conserve battery power, and to avoid being found, these culprits send only very brief coded signals, usually in Morse code, or, if spoken, only a few apparently random letters or numbers.

However, there is another side to the spy coin. Spies usually spend most of their time listening. They seldom transmit. It is assumed that the agencies that send spies out into the international community want to be able to pass along new plans or instructions to their agents. Several stations can be heard almost any time, day or night, continuously transmitting lists of numbers. These "numbers stations" are assumed to be sending coded messages to their agents in the field. Copying these transmissions is easy and some of the more talented hobbyists spend at least some of their time trying to decode the numbers stations' broadcasts.

[1] By Metro Goldwyn Mayer, based on a book by Alistair MacLean, published by Doubleday, 1967.

Clandestine and Pirate Stations

As the name implies, clandestine broadcasters operate covertly, trying to keep from being caught by the government. These stations may be running extremely weak transmitters and might have a range of less than a mile, or they may operate from mobile or maritime mobile stations which are moved constantly.

Pirate broadcasters are unauthorized stations operating illegally, but usually from a location (such as offshore from the target country in international waters) where they can't be legally stopped or easily apprehended. Pirate stations are operated by individuals or organizations that want to get "their message" across but they don't have the funds—or government approval—necessary to establish a licensed station. By definition, these stations are on the air illegally and as you might suppose, it would not be to their advantage to operate from a known location, on a specific frequency, for long periods of time. Nevertheless, some pirate stations not only solicit and receive reception reports, but they also send QSL cards, just like legitimate shortwave broadcasters. Because pirates operate more or less randomly, finding them (either on the air or on the ground, so to speak) can be difficult. Hundreds of shortwave enthusiasts actively seek pirate stations and there's almost a cult following in this area of the hobby.

Summary

From exotic music to state-of-the-art communications, many of the sounds heard on shortwave receivers can provide hours of fun, entertainment and excitement. You can spend as little or as much time as you wish on the shortwave bands and there will always be something interesting to find. Listening to ships at sea, planes in the sky, spies, pirates and propaganda. It's all there, every day, just for the listening. In the next chapter, we'll examine the VHF and UHF bands for comparison.

Expanded Listening on VHF and UHF

What's Above the Shortwave Bands

While shortwave listening brings you the world, most of what goes on around you in your own town, county and state can be tuned in as well.

The VHF-UHF bands start at 30 MHz where shortwave ends. Like shortwave, the VHF-UHF bands can be referred to by their wavelength, but, in general, the exact frequency or frequency range is used when discussing these bands. Modern VHF-UHF radios are available in both analog and digital tuning models, although continuous tuning analog dial radios are becoming scarce. Analog means that the change of frequency as the radio is tuned is continuous rather than being changed in discrete steps as is done with digital tuning. We'll cover analog and digital tuning in more detail in Chapter 5.

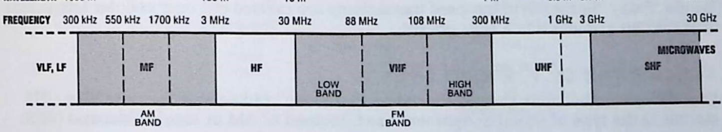
Most radios that operate in the higher frequency bands select the station frequency by digitally entering the exact frequency on a numeric keypad. These radios can be programmed with 10, 20, 50, 100, 400 or even a thousand or more individual channels that you can set and selected separately. Once the radio is programmed, it will automatically scan (step through) all of its programmed frequencies, or, a selected group of frequencies, stopping whenever it finds an active signal.

With such a VHF-UHF scanner radio, you can hear the fire trucks being dispatched to a house fire in your neighborhood before you hear the sirens or smell the smoke. Or you can listen to a high-speed chase as the police close in on an armed robber trying helplessly to escape as the police helicopter tells the officers in pursuit his every turn. Or you can hear ham operators report the track of a tornado approaching and have time to seek shelter or get out of harm's way in plenty of time.

The VHF and UHF Bands

As we have seen, and shown again in *Figure 4-1*, shortwave frequencies extend from just above the AM broadcast band to just under the lowest TV band, or from about 3 to

FIGURE 4-1. More exciting listening occurs on the VHF and UHF bands.



30 Megahertz. Above 30 MHz, the signals become even more exciting. The electromagnetic spectrum between 30 MHz and 300 MHz is called the VHF (Very High Frequency) band; and from 300 MHz to 3000 MHz it is called the UHF (Ultra High Frequency) band. Most of the UHF communications broadcast activities are below 1000 MHz. Above 1000 MHz are the microwave frequencies used for radar and long distance telephone links. Special equipment is required for receiving these signals.

Table 4-1 lists the most active VHF and UHF bands by frequency. The television bands occupy three distinct bands in the VHF-LO, VHF-HI and UHF ranges. Also shown in *Table 4-1* are the most active police, fire, ham, government, military and aviation bands. As older equipment is replaced, the trend is toward higher and higher frequencies. It is not unusual, for example, for police and fire departments to upgrade from VHF-LO to VHF-HI and again to UHF radios over the course of a few years.

TABLE 4-1. Most active VHF and UHF bands.

Frequencies	Bands	Frequencies	Bands
30- 50 MHz	VHF-LO	174-216 MHz	VHF-HI TV
50- 54 MHz	HAM	216-222 MHz	BUSINESS
54- 88 MHz	VHF-LO TV	222-225 MHz	HAM
88-108 MHz	FM BROADCAST	225-400 MHz	AVIATION
108-136 MHz	AIRCRAFT	400-420 MHz	GOVERNMENT
136-144 MHz	GOVERNMENT	420-450 MHz	HAM
144-148 MHz	HAM	450-470 MHz	UHF-HI
148-150 MHz	MILITARY	470-490 MHz	BUSINESS*
150-174 MHz	VHF-HI	470-490 MHz	UHF TV and CABLE

**Shared between business and public safety*

Several of bands shown in *Table 4-1* are shared by more than one type of service. For example, the 470-490 MHz band contains both business and public safety (fire, police, medical) services.

The VHF-UHF bands, especially the 150-MHz and 450-MHz bands, are currently used for almost all police, fire and other public safety operations in the U.S.A. During the early days of two-way radio, police, fire and ambulance services started using shortwave radio for dispatching calls and for car-to-car communications in the field. As technology advanced, equipment became smaller, lighter, more efficient and easier to use. As a result, today one sees police, firefighters and emergency medical personnel using handheld transceivers that have more features and capabilities than the mobile and portable equipment of only a few years ago. Emergency medical technicians transmit their patients' vital signs directly to the hospital emergency room via lightweight, briefcase-sized monitors fitted with radio telemetry equipment, saving precious time and often saving lives.

Business and commercial communications also use frequencies in the VHF-UHF bands. Today, thousands of business transactions are carried out over cellular telephones that fold up and slip into a shirt pocket.

Advantages of VHF and UHF

One difference between the old shortwave "two-way" radios and the new VHF-UHF models is the type of signal or emission used. Instead of AM or single-sideband (SSB)

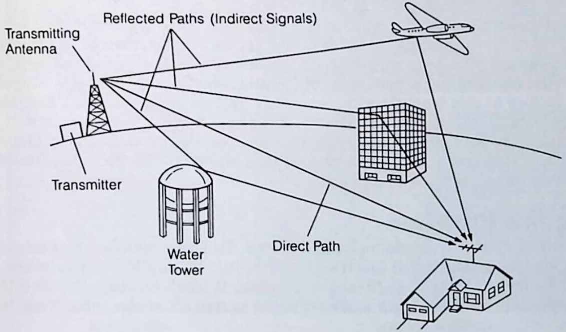
signals, VHF-UHF radios use FM or Frequency Modulation. FM has two distinct advantages over AM and SSB signals. For one thing, FM is almost immune to atmospheric noise from lightning and other static-discharge type sources such as automobile ignition systems. Another benefit is the "capture effect" of FM signals. You've probably noticed this effect as you manually tune your FM radio. As soon as you're close to the right frequency of the next station, the radio seems to lock onto the station even before you have it dialed exactly on station.

Still another advantage, although not necessarily an inherent characteristic of FM versus AM, is that the newer equipment is much easier to tune and has much greater stability. The newer radios are "channelized", with multiple frequencies being selected as simply as flipping a switch. Crystal-controlled radios existed for shortwave, to be sure, but it was the exception rather than the rule. Now, even the crystal itself is being replaced with newer technology that allows you to select frequencies with computer logic instead of quartz crystals. Part of the benefit of this technology is much lower cost. Imagine having to buy crystals for your 100-channel scanner at five or ten dollars per crystal!

VHF and UHF Disadvantages

Shortwave signals bounce off the ionosphere in order to accomplish long-range communications. At higher frequencies, the signals are not reflected but continue right through these atmospheric layers and out into space. With no such reflection of the signals back to earth, transmissions at these higher frequencies are said to be "line-of-sight". They can be reflected, to some extent, as shown in *Figure 4-2*, from buildings and even aircraft; however, for all practical purposes, VHF and UHF signals travel in a straight line and are unlikely to be receivable much farther than the geographical horizon. Natural and man-made obstructions, weather conditions and antenna type and location all affect the range of reception for VHF and UHF signals. These signals are quite effective in crowded downtown areas of large cities because of all the reflections from buildings, but in isolated areas, highly elevated or directional antennas are a paramount requirement for good reception over a reasonable range.

FIGURE 4-2. Reflection of VHF and UHF "line-of-sight" signals.



Expansion of Stations

Monitor receivers for the VHF-UHF bands quickly gained in popularity as more and more municipalities and agencies moved up to the "newer" bands. With their expanded capability, neighboring communities could watch over each other more readily. At first, these new receivers used variable frequency oscillators similar to the tuning mechanism in shortwave receivers. The analog dials covered certain frequency ranges that could be tuned continuously from the lower end of the band to the upper edge. Different bands were covered with band selection switches.

If all you wanted to do was monitor a single frequency, this arrangement was quite satisfactory. But with this type of radio it was a little awkward, if not impossible, to monitor more than one frequency. And because of the intermittent, random nature of most police and fire radio calls, it can get pretty boring listening to only one frequency if nothing catches fire and the crooks are all taking a break.

Typical Traffic

At certain times in large cities, like Dallas, Texas, for example, the fire and police departments may be dispatching two or three calls every minute. The calls can be all varieties, as simple as someone locking their keys in their car or a kitten up a tree, to one as serious as a gunman holding hostages. One call could be a one-car accident, another an airliner crash. The channels are very busy. Even in normal traffic, the primary dispatch frequency is seldom idle when you live among a million other people.

On the other hand, if you live out in the boondocks, the fire truck may only get rolled out of the fire station once a week for washing and the dispatch radio may even have a thin layer of dust on the push-to-talk button. However, somewhere in between these two extremes lies the rest of the country. The average fire department will have at least two radio channels, plus a "mutual aid" channel shared by neighboring cities or counties. The police will almost always have at least four frequencies for their own use in addition to a couple of "intercity" channels. In addition, there is the sheriff's department and the state police. Both will have their own frequencies as well. The state police (highway patrol) will have at least four channels, probably a couple of administrative channels, plus one or two for special events.

Medical Service Emergencies

In addition to the local police, fire and medical channels, there are 10 national frequencies designated "Med-One" through "Med-Ten". All across the country EMS (Emergency Medical Service) agencies are adopting these frequencies for local use, and standardizing not only emergency medical procedures, but communications equipment as well. To contribute further to this type of traffic, hospitals and medical transport helicopters and airplanes are using both standard and private communications channels.

Just counting your own local city and county fire departments, city, county, and state police, and emergency medical services, that's about 30 different frequencies. How are you going to listen to all 30 at one time?

Solving the Problem

As it turns out, it's not impossible, or even difficult. To know what's going on you will want a scanner programmed to the fire department, the police department, the ambulance, the sheriff and the state highway patrol. It turns out that the 30 different frequencies you will be scanning are almost never active all at the same time. In fact,

under normal conditions, there will be long periods where all are completely idle. On the other hand, if a major disaster, such as a train derailment, plane crash, earthquake, apartment fire, hazardous material spill, or a tornado occurred, 10 or 20 of those channels can explode with activity and become extremely exciting.

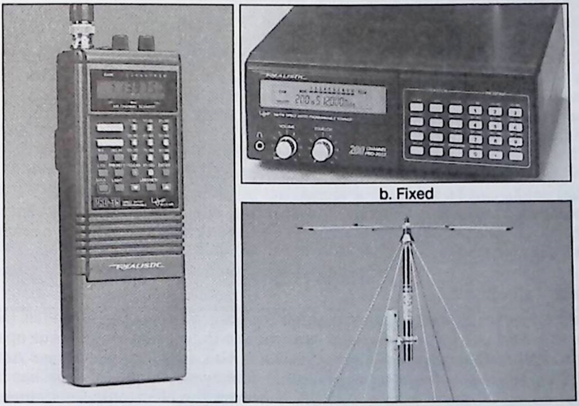
Scanners

A scanner is a special kind of radio receiver. It scans several channels automatically until a signal appears on one, then it locks onto that channel so you can hear the transmission. The introduction of the scanning receiver solved the problem of how to monitor 30, 50, even a hundred or more different frequencies. The nature of public safety communications itself also makes this type of radio monitoring even less of a task than you might first expect. Most of the frequencies you will be scanning will be quiet most of the time and normal transmissions are fairly short in duration. Instead of 20 or 50 or 100 conversations all going on at once, public safety communications in general are sporadic, brief and punctuated by long periods of silence. A scanning receiver makes monitoring these frequencies more fun since it automatically locks onto whichever agency is transmitting and can monitor several different agencies at a time. You might get bored quickly listening to the Podunk Fire Department all day long, but you won't get bored if you're also tuned in to the state police, the sheriff, your local police department, the local airport and the FBI.

Design

Two typical Radio Shack scanners and a special discone antenna are shown in *Figure 4-3*. Scanning receivers are designed to have several individual channels, rather than a tuning

FIGURE 4-3. Typical VHF-UHF scanners and Discone Antenna.



a. Portable

b. Fixed

c. Discone Antenna

dial. Each channel on a scanner can be set to a different radio frequency and each channel can be individually selected or ignored (skipped) as the receiver operates in the scanning mode. Most scanners also have their channels organized in groups or "banks" of 10 channels each so you can have, for example, police frequencies in bank one, fire frequencies in bank two, ham frequencies in bank three, federal agencies in bank four and so forth. Total flexibility in programming and operating a scanner makes it both practical and entertaining, as well as easy to use. When you get tired of listening to the police "running license plates" and stopping speeders, you can simply lock out the police channels and monitor only the fire frequencies. Scanners come in a wide variety and prices range from $50 to $5,000, depending on frequency coverage and features.

Scan Mode

The scanner will scan through a sequence determined by its programming. It will sample each individual channel in the sequence. When the scanning circuitry finds a signal on a channel, it stops on that channel allowing you to hear that particular transmission. When the transmission ends, the scanner automatically resumes scanning for another signal.

Search Mode

Another interesting feature of scanners is the search mode. Many scanners can be programmed to automatically tune from one frequency to another in any given range. For example, let's say you wanted to find out what frequencies were used in your local area by ham operators. The Users Guide that comes with the scanner will show you the different frequency bands your scanner covers, or you can use an independent frequency list (usually available wherever you buy your scanner). You find the lowest and highest frequencies allocated for a particular band. For example, the two-meter ham band extends from 144 to 148 MHz. By programming your scanner to these lower and upper limits and starting it in the search mode, the receiver will rapidly and continuously search the frequency range you specified until it finds an active signal. It will stop on the active signal and display its exact frequency. Using the search mode to monitor the chosen range of frequencies, you will soon have a list of all the active frequencies for your area. Some of the more expensive radios even have a connection for a computer to control, monitor and record statistics on which frequencies are in use and how often they are used.

One final note on scanners, we mentioned previously that most can be programmed in groups of channels called banks (typically, ten channels in each bank.) The individual banks can be selected or locked out by pressing a button or key. This makes it convenient for times when you want to hear only one certain type of activity. Some scanners let you choose how many channels each bank holds so you can customize your banks for your local area.

Scanner Laws

You should be aware that some states prohibit the possession of "police" radios (scanners) in personal vehicles. Most states make exception to these laws for amateur operators since hams help with emergency communications. Also, the Communications Act of 1934 makes it illegal to reveal the content of certain communications. This law has been around for a long time and has some merit. However, the Electronic Communications Privacy Act passed in 1989 makes it illegal to monitor cellular telephone and certain

other types of radio communications. Most experts agree that this law is an unenforceable abridgment of citizens' rights to monitor any unscrambled radio signal that is transmitted in the clear. They say that communications privacy should be the responsibility of the communicators; however, unless this law is challenged and defeated you should be aware that monitoring cellular telephones (and certain other transmissions) is illegal. Fortunately, most of the communications you can hear with a scanner or shortwave receiver are transmitted unscrambled and are not restricted. There is plenty to hear and enjoy on the VHF-UHF bands and will be for many years to come.

Antennas for VHF-UHF

As we tune higher in frequency the wavelengths get shorter and so do the antennas. In the VHF-UHF bands where wavelengths are anywhere from six feet to six inches, very effective antennas can be made using common materials including telescoping whips on portable radios. The simple telescoping or flexible "rubber duck" antenna that comes with most scanners is usually adequate for most situations. If you live within 10 or 20 miles of the center of town, you'll probably pick up all the local action with the antenna that comes with the receiver.

To hear signals from 20 or 30 miles away, you will want an outside antenna on your house or car. Good reception up to 100 or more miles can be had with directional antennas (called "beams") and the higher the antenna, the better. As with shortwave reception, the antenna is the most important part of your receiving system. Careful planning and installation can greatly improve your reception. Unlike transmitting antennas, which must be properly designed and tuned for the operating frequency, receiving antennas are less critical in construction. You can buy single- or multi-band antennas for less than $50 or you can even make your own out of heavy gauge wire or small diameter metal tubing or pipe. A personal favorite is a discone antenna.

The discone antenna, shown in *Figure 4-3c*, is an unusual-looking antenna, but it is designed to cover a very wide range of frequencies and can be very effective up to 50 or more miles when installed in the attic or on the roof of your house. Discone antennas get their name from the fact that they have a disk-shaped top section and a cone-shaped bottom section. A discone antenna sold by Radio Shack (RS 20-013) is designed to cover from 25 to 1300 MHz. That's the entire VHF-UHF spectrum!

Listening In

After several years of monitoring the VHF-UHF bands, it is recommended that you program at least one bank in your scanner with a few choice frequencies that may not be very active, but when they do have activity, it's usually something important. For example, *Table 4-1* shows several frequencies that are great to listen to when the president is in town.

TABLE 4-1. Selected frequencies for presidential visits.
(The names in quotations are channel designators)

165.3750 MHz "Charlie"	415.6750 MHz "Black"
165.7875 MHz "Baker"	415.7000 MHz "Fox"
169.9250 MHz "Delta"	407.8250 MHz Pocket Radios
166.2125 MHz "Hotel"	407.8725 MHz Pocket Radios
165.2125 MHz "Mike"	407.9250 MHz "India"

The frequencies listed in *Table 4-2* are used by the FBI. Unfortunately, in many areas of the country the FBI has started using digital encryption to mask their transmissions; however, some routine communications can still be heard on several of these frequencies.

TABLE 4-2. Frequencies used by the FBI.

163.9100 MHz	167.7375 MHz	167.6125 MHz	163.9125 MHz	167.2500 MHz
167.4375 MHz	167.7875 MHz	163.8625 MHz	163.9875 MHz	167.2750 MHz

Often the fire department will dispatch calls on one frequency and the firefighters will use another channel en route and while working the incident. The local dispatch frequencies for fire, police sheriff, state police, and a few more can be programmed in your VHF-UHF scanner to keep you informed whenever anything important breaks. *Table 4-3* shows some specific examples.

These frequencies are ten of the most interesting in the Fort Worth-Dallas area. In most large metropolitan areas, you can find similar frequencies that are seldom used, but very exciting when they do get active.

TABLE 4-3. Selected "top ten" frequencies for the D/FW area.

121.5000 MHz	Aviation Emergency Channel
154.9500 MHz	All-Texas Intercity Police (Mobiles)
155.3700 MHz	All-Texas Intercity Police (Base)
155.4600 MHz	Texas Highway Patrol Dispatch
460.1250 MHz	Dallas Police Tactical (SWAT) Channel
460.3000 MHz	Fort Worth Police Tactical Channel
460.3500 MHz	D/FW Airport Police
460.4500 MHz	D/FW Airport Fire
482.4125 MHz	Arlington Fire Dispatch
856.4375 MHz	Fort Worth Fire Dispatch

In *Table 4-3*, the three 150-MHz frequencies are good over the entire state of Texas; and the aviation emergency frequency, 121.500 MHz, is used all over the North American continent. Part of the fun of scanning can be exploring what you can find and creating your own favorite list of frequencies to monitor.

Summary

The VHF-UHF bands hold many other exciting things to keep your attention. There is everything from taxi cabs to airplanes, all manner of security services, government agencies, business communications, sports car drivers, military and aviation, all kinds of amateur activities, and even the Secret Service! You can listen to undercover agents, the FBI, the DEA and the IRS. You can hear newspaper, radio and television reporters talking to their newsrooms before you hear their actual newscasts. You can even hear what the person in the car in front of you is ordering when you visit your favorite fast-food restaurant. And, as we mentioned in Chapter 2, you can monitor the astronauts during each shuttle mission. The VHF-UHF bands pick up where the shortwave bands leave off. In the next chapter, we'll talk about equipment for listening.

CHAPTER 5

Equipment for Listening

Your First Receiver

Shortwave listening can be one of the most interesting hobbies you will ever discover. And you only need three things to participate, a shortwave receiver, a good antenna (some receivers come with built-in antennas) and a little time.

Since we're dealing with world-wide communications, time is on your side for a change. You can pick and choose the times you wish to listen, based on your personal schedule. No matter what time of day or night you decide to tune the bands, there will be hundreds of signals on the air for you to hear.

Buying your first shortwave receiver can be a lot of fun and very rewarding if you do your homework first. Reading books like this one should be the first step, of course. And there are monthly magazines devoted to shortwave listening that can provide a wealth of information on what to look for in your first world band receiver.

In this chapter, we will explain the features available on receivers from the basic necessities to the "bells-and-whistles" options, plus how to set up an external antenna. First, you should know that you do not have to spend a lot of money to get a good receiver. Many older models still have plenty to offer and can be quite a conversation piece as well. At a recent convention for radio and electronics hobbyists, your author was guest speaker on one of the programs presented specifically for those interested in shortwave listening and VHF-UHF scanning. As part of the program, we had a couple of radios set up to demonstrate what could be heard across the bands and to compare the features of both the older and newer models available.

One of these radios was a new solid-state, all-mode, continuous coverage communications receiver that had enough switches, knobs and buttons to make Captain Kirk ask Mr. Spock for help. The other radio was an old portable shortwave receiver with an on/off/volume control, tuning dial, and band-change switch. The new radio had a liquid crystal display (LCD) which showed frequency, time and several other functions while the older one had a slide-rule-like tuning dial behind a large glass window. The new radio was compact, light-weight and smaller than its older cousin, which was encased in a wood-and-leather case that reminded some in the audience of the 1920's, which was about the time it was built.

The old workhorse still had plenty to offer. As we tuned it across the shortwave bands we easily found the BBC in London, the VOA, Radio Moscow and several other English language broadcasts. Tuning the new radio to the same frequency for a spontaneous comparison, the audience was amazed to hear that the sound from the timeworn portable actually sounded better than the sound from the mint-condition, expensive one. We explained that, in this particular case, we were listening to a very

strong signal which either of the two radios could pick up easily, and that the much larger speaker in the older radio naturally sounded "better" than the smaller speaker in the new radio. This points out an excellent feature to look for in your new receiver. The provision to connect an external speaker is a very desirable feature on any radio.

Further direct comparisons, using the built-in, telescoping antennas on both radios inside the building where the demonstration was taking place, quickly showed that the new radio could pick up signals the older one could not. Here's another excellent and desirable feature for your new receiver—an external antenna connection.

How Much Will It Cost?

The demonstration proved that older radios, though lacking in some features, performance and refinements, are still a viable alternative to spending a lot of money on a brand-new radio. If you are lucky enough, you may find a vintage portable or table model shortwave radio at a flea market or garage sale. Its cost may be somewhere between $10 and $100, depending on whether or not it's working and its physical condition. One thing to remember about older radios is that most TV repair shops, or even your neighborhood ham operator, may be able to fix them quite inexpensively. Even tube-type antiques can be restored if you know where to find a supply of vacuum tubes. Don't turn down anyone offering you an antique radio for $10, even if it doesn't work. There are collectors looking for these radios, and you can double your investment if you don't want to keep the radio.

At the other end of the expense spectrum you can expect to spend almost $5,000 for a top-of-the-line, do-everything receiver, including one with a printer port for printing weather satellite photos and FAXes directly from the receiver.

From the simple to the supreme, it's not hard to find more than one receiver with enough gee-whiz features to keep even the most psychotic, button-pushing, knob-turning, switch-flipping hobbyist happy for decades. So, with such a wide selection available, how do you pick the one that is right for you?

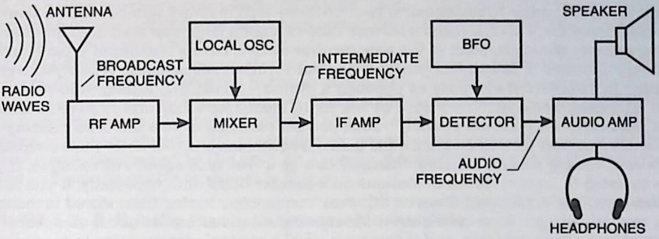
Choosing the Right Receiver

Before you run out and buy any shortwave receiver, it will be well worth your time to read everything you can find on the subject. Fortunately, there are many sources. The shortwave magazines previously cited and similar communications trade magazines are your best source. These should be available at a local library or bookstore. For our discussion, we'll concentrate on the most important functions and specifications.

Block Diagram of a Typical Receiver

Let's start with a simple explanation of how a receiver works and build on it. Look at *Figure 5-1*. As we mentioned earlier, radio signals are waves of electromagnetic radiation that are emitted from transmitting antennas and intended to be picked up by receiving antennas far away. The first stage in a typical receiver is an amplifier designed to boost the minute voltages and currents from the receiving antenna to levels high enough to be useful. The signal is mixed with the output frequency of an independent signal generator called the local oscillator to produce an intermediate frequency that is, in turn, fed into a detector stage. The intermediate frequency is easier to handle and amplify than the frequency of the original signal received. The detector separates the audio signals from the higher intermediate frequency so they can be amplified by the audio amplifier stage which drives a speaker or headphones. The sounds from the speaker or headphones are the same sounds that originated at the transmitter.

FIGURE 5-1. Typical receiver block diagram.



Many other circuits are present in modern receivers, but the ones outlined above are the most fundamental and necessary for a radio to work. In plain English, very weak signals picked up by the receiving antenna from passing radio waves are passed through several stages in a receiver that are designed to filter out unwanted signals, amplify the desired signal, convert that signal so the audio signals can be recovered, and amplify the audio to drive the speaker or headphones so the audio sound can be heard by the listener.

Frequency Coverage

The range of frequencies covered is perhaps the first thing we think about when shopping for a shortwave radio. That's fine, but, as we will see, several other features need to be considered as well. Frequency coverage can be classified into several categories, e.g., general coverage, multi-band, and continuous coverage. Here might be a good place to point out the differences. General coverage usually means that the receiver is designed to cover all frequencies between 3 and 30 MHz. However, some general coverage receivers will work as low as 150, 100 or even 30 kHz (0.03 MHz). Multi-band means that the receiver is designed to cover its operating frequencies in several discrete, separate ranges, perhaps matched to the standard international shortwave broadcast bands. Continuous coverage means that, regardless of the lowest and highest frequencies covered, there are no gaps anywhere—this type of radio will receive any frequency between the lowest and highest frequency specified. All continuous-coverage receivers cover multiple bands, but not all multi-band receivers provide continuous coverage.

Band-Switching

Band switching means that the frequency band that the internal circuits of the receiver will respond to is changed. This is accomplished with a band-change control. While some receivers can be tuned continuously from one frequency to another, across several bands, others require you to switch bands by turning a rotatable switch or pressing the appropriate band-selection button. On some radios, you can preset different frequencies in different bands by storing them in memory. You can then switch between the different frequencies quickly by simply changing bands. This feature is especially useful if you want to compare the signal strength of the same station transmitting simultaneously on different frequencies in different bands—a common practice among shortwave broadcasters.

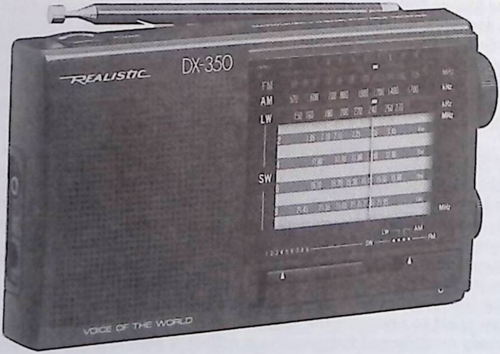
Memories

Memories allow you to store station frequencies so they can be selected at a future time. It's often easier to remember a two- or three-digit memory number than a five- or six-digit frequency. It also takes a lot less time changing from one station to another by using memory channels. Most of the new receiver models have a number of programmable memory channels that you can preset with your favorite frequencies. When you want to tune in a station, it's as easy as pressing a button—no dialing, tuning, fine-tuning and adjusting. Some receivers have as few as 10 memories while others have as many as 1,000. Here's a personal opinion—once you get past one or two hundred memory channels, you may as well memorize the actual frequencies and just enter them manually! However, having several memory channels can be a real time-saver. For example, if you like to listen to several different stations on a regular basis and, especially, if you listen to those stations at different times on different frequencies, having them stored in memory is a real advantage. Remember, most shortwave broadcasters transmit on several frequencies simultaneously, and if you have all of a station's frequencies in memory channels, it's very easy to tune to the frequency that has the strongest signal at the moment.

Analog or Digital Tuning

There are two types of frequency displays available—analog and digital. On the older models, analog really was your only choice. Vintage receivers have large glass windows behind which you can see a dial with several rows of numbers and a sliding bar that moves back and forth from one side to the other as you turn the tuning knob. This is analog tuning. As you sweep the sliding bar indicator across the dial, the frequency to which the receiver is tuned is changing smoothly and continuously. An example of an inexpensive, multi-band, analog-tuned receiver is shown in *Figure 5-2.* Some of the older dials are even marked with the names of countries or cities to show where you could

FIGURE 5-2. An analog-tuned, multi-band receiver.



find stations broadcasting from the indicated locations. Unfortunately, things change and many of the markings are obsolete. Fortunately, some things change for the better and the newer receivers now use liquid crystal display (LCD) readouts that show the operating frequency digitally as you sweep across the dial. You can even find some radios that have both analog and digital dials.

For digital tuning, frequencies are entered on a numeric keyboard. As you enter a new frequency by pressing the buttons, digital logic circuits in the radio tune the receiver to the exact frequency entered. The frequency is displayed on a LCD display. New frequencies are selected by entering either the frequency or the memory channel number previously stored. With programming, pre-selected frequencies can be selected in a sequence determined by the user. An example of a shortwave receiver that is digitally tuned and programmable is shown in *Figure 5-3*.

FIGURE 5-3. A digitally-tuned, programmable receiver.

In the old days, you had to adjust your tuning dial slowly and carefully as you listened for the station you wanted. Now you can simply dial in the exact frequency, or use the numeric key pad to enter it directly. Both analog-tuned and digitally-tuned receivers may have a fine-tuning control. On some receivers this is called the RIT control, for receiver incremental tuning. This control, if present, allows you to adjust the receiver frequency in smaller increments than the main tuning dial. On some models it's simply called the fine-tuning control. On analog-tuned receivers, a fine-tuning control makes it easy to make small adjustments as you tune in each station. But even though you can enter an exact frequency with a digitally-tuned receiver, an RIT control is a handy feature, because it can be used to reduce interference.

Signal Strength Indicators

Receivers with LCD readouts often incorporate a signal strength indicator in the same display as the frequency. Others may use a separate meter. Still another has a built-in spectrum display that shows all signals within a given range either side of the operating frequency. The relative strength of each signal is shown as a pip or vertical line rising from the bottom of the spectrum display. Each line represents a separate RF signal and the height of the pip or line indicates each signal's relative strength. If you're searching for a really weak signal on a very noisy or crowded band, such a display can make it easy to lock onto the desired signal, or to reduce interference.

Sensitivity

Sensitivity refers to how well a receiver can "hear." The more sensitive the receiver, the weaker the signal it can receive successfully. Sensitivity is measured in microvolts and when testing different receivers, engineers use highly-calibrated instruments. They measure a receiver's performance based upon how strong a signal must be for the receiver to detect it, isolate it and make it available to the listener at a certain volume or loudness level. Fortunately, advances in electronics technology have come so far and are so widely used by all communications equipment manufacturers that there is very little difference between most of today's receivers. In fact, radios that cost less than $200 today are far more sensitive than commercial receivers costing ten times that amount only a few years ago. Most advertisements for shortwave receivers don't even mention sensitivity any longer since the competition is so evenly matched as far as this particular performance factor is concerned.

Selectivity

While sensitivity may be almost equal among receivers today, one area where you can find differences is in selectivity. Selectivity is a measure of a receiver's ability to pick out one particular signal from amongst several other nearby signals. This is akin to being able to hear one person speaking in a crowded room full of people all talking at once. In a very crowded shortwave band, there may be one or more signals very close to the one you're trying to hear. The other signals may even be much stronger than the one you want. Two things help in this situation. One is the receiver's selectivity, or ability to reject strong adjacent signals; the other is the type and amount of filtering available.

Filters

Filters are internal circuits that are designed to pass certain signal frequencies and reject others. Even the most inexpensive receivers have some filtering, if only by means of a tone control that lets you adjust the pitch of the audio you hear coming from the speaker. Under certain conditions, simply adjusting the pitch can help a lot; however, the most effective means of rejecting interference is with filters. There are several types of filters and each one is designed to filter out a particular type of interference.

A "notch" filter is very effective in cutting out a narrow frequency band where a near-by signal is interfering with the desired station. Notch filters can be incorporated in the circuits that amplify the intermediate frequency signals (the IF section) or in the audio circuits. Such IF notch filters are very effective and can almost eliminate certain types of interference completely. Audio notch filters, while not as effective as IF notch filters, can be useful, and can greatly reduce the effects of strong, interfering signals.

Single-Sideband and CW Reception

As we discussed briefly in previous chapters, there are a variety of different kinds of signals to be found on the short-wave bands. International shortwave broadcast stations all use AM, or amplitude modulation. However, if you want to listen to ships at sea, ham operators, military and other types of transmissions, you will want a receiver that is capable of receiving CW signals and single-sideband signals. SSB signals are a special type of transmission used particularly on shortwave bands.

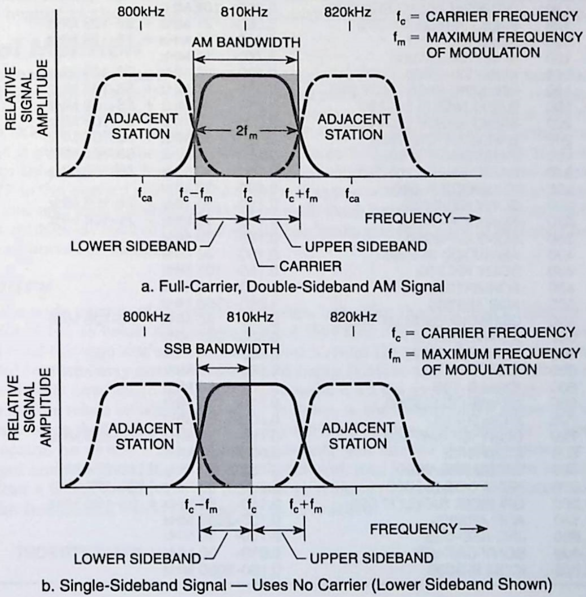
The main difference between AM and SSB signals is that with an AM signal the audio frequencies are superimposed on a carrier wave, while on SSB signals, the carrier frequency is suppressed by the transmitter, leaving only one of the two sidebands normally associated with an AM signal. *Figure 5-4* shows an AM signal and a SSB signal

for comparison. The AM signal uses twice the bandwidth used by the SSB signal. When an AM signal is displayed on an oscilloscope, the sounds being carried by the signal can be seen riding on the upper and lower sides of the center, or carrier, frequency. These frequency bands are called sidebands. In an SSB signal, the carrier frequency has been filtered out, along with either the upper or lower sideband and only the opposite sideband of the signal remains. The advantage of this mode of transmission is that power that was being spent sending the carrier wave and the other sideband can now be added to the remaining signal and thus more range can be obtained. Since each sideband of the original signal contains the same signal information as the other, nothing is lost.

Since received SSB signals have no carrier wave present, and since a receiver must have a reference, or "beat" frequency, to apply to any signal it's receiving, receivers designed to pick up SSB signals have an internal reference frequency generator, called a beat-frequency oscillator, or BFO. The BFO circuit supplies a steady frequency internally, replacing the "missing" carrier frequency which was removed from the SSB signal at the transmitter. The BFO circuit also allows you to receive Morse code signals.

FIGURE 5-4. AM signals have both sidebands and carrier present; SSB signals only have a sideband, no carrier.

Source: Mobile 2-Way Radio Communications, *G. West, ©1993, Master Publishing, Inc.*



If you think you will be interested in listening to SSB and CW signals, be sure that the receiver you choose has a BFO or specifically states that it receives SSB and CW signals.

Comparison of Shortwave Receivers by Price

Table 5-1 lists several models of shortwave receivers arranged by price and showing the manufacturer, model number and frequency coverage. This is a quick and easy way to compare radios in a general price range. The prices shown in *Table 5-1* are not the manufacturers' recommended list prices. They are prices that have been averaged from several sources and may vary greatly from one dealer to another. For that reason, when ready to purchase, comparison shopping is definitely in order.

TABLE 5-1. Shortwave receivers by price.
(Prices vary greatly depending upon source)

Price	Manufacturer/Model	Frequency Coverage
$ 60	RADIO SHACK DX-350	0.150- 30 MHz + 88-108 MHz
60	SANGEAN SG-796	0.300- 30 MHz + 88-108 MHz
100	GRUNDIG TRAVELLER II	0.150- 30 MHz + 88-108 MHz
100	SONY ICF-SW20	0.150- 30 MHz + 76-108 MHz
120	GRUNDIG YACHT BOY 220	3.900- 108 MHz
120	RADIO SHACK DX-370	3.200- 21 MHz + 88-108 MHz
120	SONY ICF-7601	0.100- 30 MHz + 76-108 MHz
130	SONY ICF-SW800	3.700- 18 MHz
170	SONY ICF-7700	0.100- 30 MHz + 76-108 MHz
180	GRUNDIG YACHT BOY 230	0.550- 26 MHz + 88-108 MHz
180	RADIO SHACK DX-380	0.150- 30 MHz + 88-108 MHz
200	RADIO SHACK DX-440	0.150- 30 MHz + 88-108 MHz
200	SANGEAN ATS-803A	0.150- 30 MHz + 88-108 MHz
200	SANGEAN ATS-808	0.150- 30 MHz + 88-108 MHz
240	RADIO SHACK DX-390	0.150- 30 MHz + 88-108 MHz
300	KENWOOD R-600	0.150- 30 MHz
300	SONY ICF-SW55	0.150- 30 MHz + 76-108 MHz
320	SONY ICF-SW1S	0.150- 30 MHz + 76-108 MHz
360	SONY ICF-2010	0.150- 30 MHz
400	KENWOOD R-1000	0.100- 30 MHz
400	SONY PRO-80	0.150- 108 MHz
430	AOR AR1000	0.500-1300 MHz
500	AOR AR2500	1.000-1500 MHz
500	GRUNDIG SATELLIT 500	0.150- 30 MHz + 88-108 MHz
500	KENWOOD R-Z1	0.500- 905 MHz
500	SONY ICF-SW77	0.150- 30 MHz
600	ICOM R-1	0.100-1300 MHz
600	ICOM R-100	0.100-1856 MHz
650	KENWOOD R-2000	0.150- 30 MHz
700	ICOM R-71A	0.100- 30 MHz
720	SONY ICF-SW7600	0.150- 30 MHz + 76-108 MHz
800	ICOM R-72	0.030- 30 MHz
800	YAESU FRG-8800	0.150- 30 MHz +118-174 MHz
900	KENWOOD R-5000	0.100- 30 MHz +108-174 MHz
1,000	GRUNDIG SATELLIT 650	0.150- 30 MHz + 88-108 MHz
1,100	AOR AR3000	0.100-2036 MHz
1,800	JRC NRD-535	0.100- 30 MHz
4,400	SONY CRF-V21	0.030- 30 MHz + W/FAX PTR PORT
4,700	ICOM R-9000	0.100-2000 MHz

Table 5-1 is intended only for a quick and general reference to give you an idea of how prices run for some of the most popular receivers. As you can see, a new receiver may cost less than $100 or more than $4,000, and in almost every $100 increment there is more than one radio. If cost were not important, the choice might be easier with only the top 4 or 5 receivers to choose from, but competition among manufacturers offers us many features at each price point.

Comparison of Receivers by Frequency Coverage

Let's take another look at the same receivers, arranged in a different way. Using frequency coverage as the key, we get the list shown in *Table 5-2*. This is an interesting presentation but really not much use. First, there is not much difference between 100 kHz and 150 kHz for a starting point. Signals below 150 kHz are mostly CW or RTTY and probably not very interesting to the casual listener. Also, several of these receivers have gaps, or missing frequency ranges while others are continuous in their coverage from the lowest to the highest frequency. This is one feature to be aware of right from the start. While most listeners may be perfectly happy with a good "multi-band" receiver, others may be very interested in what's "missing". Investigate the frequency coverage carefully to make sure the receiver you choose satisfies your needs.

The frequency ranges shown in both *Table 5-1* and *Table 5-2* are intended for general comparison purposes only. In some cases, coverage may not be continuous, or the exact beginning and ending frequencies may be slightly different than shown.

Special Mention

One radio that deserves special attention is made by Philips, the Holland manufacturer who has long been a leader in automotive electronics. The Philips DC-777 is designed to mount in the dash of your car or truck as a replacement for the standard AM-FM car radio. The DC-777 not only receives the standard AM-FM bands and has a built-in cassette player, but it also covers the shortwave bands from 3.17 to 21.91 MHz (13- to 90-meter bands). For those who don't want an extra radio hanging out from under the dashboard, the DC-777 is the perfect solution. And since it appears to be "built-in", it attracts less attention and may be a deterrent to theft as well. Push-button tuning of up to 5 different frequency settings on each of the four selectable banks makes it easy to find your favorite AM, FM or shortwave station.

Summary

With such a wide variety of receivers available, selecting the one that's right for you can be a lot of fun in itself. And when you get that new receiver home, do yourself a favor and read the operator's guide before you turn on the radio. Some of the controls and special features may not be obvious and being familiar with all the controls and functions of your new world band radio will make it all the more enjoyable.

No matter when or where you want to listen to shortwave radio, there are several kinds of receivers that will fit the bill. Visit your local dealer. Ask questions. If you know a ham operator, he or she will be delighted to help you choose the right receiver for your budget and interests. If you do your homework and know what you're looking for, you will find a world band receiver that will provide many hours of enjoyment as you explore the fascinating world of listening to shortwave.

TABLE 5-2. Shortwave receivers by frequency coverage.
(Note: Frequency ranges shown are not complete manufactuers' specifications and not all are continuous coverage)

Frequency range(s)	MFR/Model	Price
0.030- 30 MHz	ICOM R-72	$ 800
0.030- 30 MHz + 76-108 MHz	SONY CRF-V21 (W/FAX PTR PORT)	4,400
0.100- 30 MHz	ICOM R-71A	700
0.100- 30 MHz	JRC NRD-535	1,800
0.100- 30 MHz	KENWOOD R-1000	400
0.100- 30 MHz + 76-108 MHz	SONY ICF-7601	120
0.100- 30 MHz + 76-108 MHz	SONY ICF-7700	170
0.100- 30 MHz +108-174 MHz	KENWOOD R-5000	900
0.100-1300 MHz	ICOM R-1	600
0.100-1856 MHz	ICOM R-100	600
0.100-2000 MHz	ICOM R-9000	4,700
0.100-2036 MHz	AOR AR3000	1,100
0.150- 30 MHz	KENWOOD R-2000	650
0.150- 30 MHz	KENWOOD R-600	300
0.150- 30 MHz	SONY ICF-2010	360
0.150- 30 MHz	SONY ICF-SW77	500
0.150- 30 MHz + 76-108 MHz	SONY ICF-SW1S	320
0.150- 30 MHz + 76-108 MHz	SONY ICF-SW20	100
0.150- 30 MHz + 76-108 MHz	SONY ICF-SW55	300
0.150- 30 MHz + 76-108 MHz	SONY ICF-SW7600	720
0.150- 30 MHz + 88-108 MHz	GRUNDIG SATELLIT	650
0.150- 30 MHz + 88-108 MHz	GRUNDIG SATELLIT 500	500
0.150- 30 MHz + 88-108 MHz	GRUNDIG TRAVELLER II	100
0.150- 30 MHz + 88-108 MHz	RADIO SHACK DX-380	180
0.150- 30 MHz + 88-108 MHz	RADIO SHACK DX-390	240
0.150- 30 MHz + 88-108 MHz	RADIO SHACK DX-440	200
0.150- 30 MHz + 88-108 MHz	SANGEAN ATS-803A	200
0.150- 30 MHz + 88-108 MHz	SANGEAN ATS-808	200
0.150- 30 MHz + 88-108 MHz	RADIO SHACK DX-350	60
0.150- 30 MHz +118-174 MHz	YAESU FRG-8800	800
0.150- 108 MHz	SONY PRO-80	400
0.300- 30 MHz + 88-108 MHz	SANGEAN SG-796	60
0.500- 905 MHz	KENWOOD R-Z1	500
0.500-1300 MHz	AOR AR1000	430
0.550- 26 MHz + 88-108 MHz	GRUNDIG YACHT BOY 230	180
1.000-1500 MHz	AOR AR2500	500
3.200- 21 MHz + 88-108 MHz	RADIO SHACK DX-370	120
3.700- 18 MHz	SONY ICF-SW800	130
3.900- 108 MHz	GRUNDIG YACHT BOY 220	120

Amateur Radio

What is the Amateur Service?

One of the most interesting services to be found in the shortwave bands is Amateur Radio. Amateur operators, or "hams" as they're called, operate several bands on the shortwave frequencies. Amateurs come from all walks of life and range in age from 8 to 80. Almost every race, color, creed and profession is represented by hams, from chimney sweeps to kings. They maybe clerks and clergymen, politicians and preachers, bankers and bookkeepers, teachers and students, astronauts and cosmonauts, singers and song writers, poets and painters, doctors, lawyers and Indian chiefs. The infinite diversity of hams is just one of the reasons that they are fun to listen to on shortwave and other bands. And the diversity of their stations, equipment, skills and ingenuity is what makes Amateur Radio such a viable and important resource.

The Amateur Radio services, under the Federal Communications Commission (FCC), consist of the amateur service, the amateur satellite service, and the radio amateur civil emergency service. The amateur service exists under international treaty, and is authorized in almost every country in the world. Amateurs are allocated several different frequency bands, and they can talk with one another on local, national and international levels. The FCC authorized amateur bands are shown in *Figure 6-1*. Reciprocal licensing allows hams in one country to operate as they travel in other countries. It is not uncommon for hams in a host country to invite visiting hams to spend an afternoon or evening in their homes. And what better way to find all the best places to visit than by talking with people who live there? Contacts and arrangements are often made by shortwave radio before trips, and amateurs in the host countries are always eager to share their customs and cultures and to provide helpful information to visiting hams. The Amateur Radio services are more than internationally recognized communications organizations; they are a society in themselves, with individuals of different races, creeds, religions, backgrounds and language, all sharing a common bond of human curiosity and exploration.

Emergency Communications

During large-scale natural disasters like volcanoes, floods, hurricanes, tornadoes and earthquakes, when all other lines of communication are virtually obliterated, Amateur Radio survives and becomes the only link to the outside world from the stricken area. Even local, man-made disasters, like plane crashes, large fires and train wrecks, though smaller in scale, benefit from ham radio. When the local fire and police and medical services are overloaded, hams, trained by the very agencies they are helping, pitch in

FIGURE 6-1. The amateur bands.

Band (wavelength)	Frequency (MHz)
160 meters	1.80-2.00
80 meters	3.50-4.00
40 meters	7.00-7.30
30 meters	10.10-10.15
20 meters	14.00-14.35
17 meters	18.068-18.11
15 meters	21.00-21.45
12 meters	24.89-24.99
10 meters	28.00-29.70
6 meters	50.00-54.00
2 meters	144.00-148.00
1.25 meters	222.00-225.00
0.70 meters	420.00-450.00
0.35 meters	902.00-928.00
0.23 meters	1240.00-1300.00
0.1-0.001 meters	3-300 GHz

to handle much of the emergency communications that are vital to saving lives during the first crucial minutes. Hams also help with the follow-up work, such as damage assessment, shelter management, and health-and-welfare communications. Even the public broadcasting news services depend upon amateur operators for the first reports direct from the scene.

None of this would be possible without two important aspects of the amateur service. First, it is an all-volunteer service. Amateur Radio equipment is privately owned and operated by individuals scattered randomly across the towns and countryside of most nations in the world. The arbitrary locations of so many amateur stations assures that not all will be affected by any one particular disaster. Many independent stations close to or even inside the disaster-stricken area will survive and remain operational. The second factor that assures a reliable source of communications at all times is the emergency preparedness and training that most hams undergo in order to be effective in almost any emergency. It is this willingness to cooperate, learn, train and help others, plus an above-average knowledge of and experience level in communications that makes the amateur service a reliable back-up when normal lines of commumications fail.

Because hams are willing to participate in various training and emergency preparedness programs, local, state and federal agencies respect and trust them to handle emergency communications in a very professional manner. Several police and fire departments across the United States maintain special vehicles (usually a motor home or large van) used as mobile command posts for use at the scene of any major disaster. These vehicles are equipped with their own electric power generators, and have separate operating positions for several radio operators. Many include a position for an amateur operator right alongside the command radio operator, and they depend upon ham radio to cover areas and agencies to which they would not normally have access. In some cities, ham radio clubs maintain their own emergency communications vehicles, and they are given a police escort to the scene and are parked near the police and fire command vehicles.

What Do Hams Do When There's No Emergency?

Of course, if the only communicating hams ever did was emergency communications, it would be pretty boring most of the time. So what do hams do when there's no emergency? It's a long list, so we'll just hit a few of the highlights.

We've already mentioned the fact that amateur stations are pretty well scattered across the country and across the globe. Another interesting aspect of listening to Amateur Radio is the diversity of individual interests among hams, and all the different types of communications they use. Since they are multifarious by nature, that alone makes conversations interesting among hams as they meet each other on the air and discuss their respective interests between themselves. They enjoy talking about their common interests. So, right away, we have two types of conversations, one being a sort of introductory, getting-acquainted dialogue; and the other being idle chit-chat between old friends. On the shortwave bands, this can be intriguing in either case. As you tune across an active amateur band, you will hear a variety of both types of conversations. Some conversations may be boring because the hams are talking about the weather or their hernia operation or the lack of jobs or the drought. Others maybe playing chess over the air. And others will be talking about their equipment and how they found a way to get more efficiency out of their antenna. If the conversation doesn't appeal to you, keep on tuning; the next one you hear may be right up your alley. Many U.S. amateurs practice their Spanish by having regular, scheduled conversations with new-found friends in Spain or Mexico or South America.

Closer to home, on the VHF-UHF bands, you'll hear hams talking to each other on their mobile radios as they drive to and from work each day. These conversations usually cover current events, local happenings, club meetings, swap meets, and of course, how to get more efficiency out of an antenna.

Different Amateur Operating Modes

FM Operation

Hams not only use many different frequency bands, they can also use different modes of communication. The modes used to carry voice are AM, SSB and FM. Most shortwave stations discussed in Chapter 2 and 3 use AM or SSB. We discussed FM in Chapter 4 and stated that it was usually clearer sounding and less affected by static noise than AM radio. Because the FM receiver is sensitive only to changes in the frequency of the received signal, it is able to discriminate against AM or non-FM signals. Since most noise is amplitude-modulated, it is ignored by FM receivers. Although FM can technically be used below 30 MHz, SSB is the predominant mode used by amateurs in the shortwave bands. Above 30 MHz, amateurs use FM for most voice communications.

CW Operation

CW was the original mode of operation for hams. Today many hams, both old-timers and newcomers alike, still enjoy using the Morse code for communicating, especially on the shortwave bands. CW signals have the ability to get through interference better and reach longer distances with less power than voice or digital signals. For one thing, all the power used in sideband signals can be concentrated in the carrier frequency. For another, sharper filtering can be applied to a CW signal without losing any information in the signal.

Although proficiency in sending and receiving Morse code has been dropped for the Technician no-code Class entry-level operator license in the amateur service, CW

is still required by international treaty for hams wishing to operate on frequencies below 30 MHz. If you are interested in learning Morse code, there is no better way than to listen to on-the-air broadcasts of code practice.

Packet Radio

We've already discussed RTTY signals and you know they are a form of digital communications intended to be sent and received using automatic encoding and decoding equipment, and using key-boards and printers for the information being sent and received. Another form of digital communications that has attained wide-spread use in recent years is packet radio. Packet radio is a very active mode of operation for amateurs. Packet radio signals on the shortwave bands sound a little like SITOR and AMTOR, in that they consist of two audio tones being alternated at a high rate of speed. Unlike AMTOR, however, in which the sending and receiving stations are using synchronous communications, packet signals are asynchronous. Simply stated, when two stations are using packet radio to communicate, the first station transmits from one to seven bursts (called packets), each containing up to 255 characters of text, and then waits for the receiving station to send back an acknowledgment that all the packets were received okay. If the sending station does not receive any acknowledgment after a short time, it will send the same data again.

Packet radio can be used for "keyboard-to-keyboard" communications, however, it is more suited for "message-based" communications. The difference is that in keyboard communications, the operators are both present at their respective stations as they are communicating with each other; whereas, with message-oriented packet radio, complete messages are stored on a computer-based controller or packet bulletin board system (BBS) and automatically forwarded to their destination by relay from one BBS to another. An international BBS network has been developed by amateurs. Every network packet radio BBS computer in the world contains sophisticated software and data related to the BBS itself and to each BBS user. The computers exchange information with each other in order to be able to route messages automatically between users and to distribute bulletins of interest to all of the BBSs in the network.

Repeaters

Amateurs use a repeater mode of operation to relay their transmissions over great distances. Repeaters are used primarily on VHF and UHF bands, although there are quite a few set up on the 10-meter amateur band just below 30 MHz. Repeaters are designed to relay signals from low-power stations over greater distances than those stations can achieve by themselves. Amateurs with handi-talkies, for example, can communicate hundreds of miles, even coast-to-coast in some cases, using repeaters that also have a "remote-base" or "cross-band" capability. Typically, however, repeaters are set up to cover only a given area, like a town or county. Repeaters receive an incoming signal on their input frequency and simultaneously transmit that signal on their output frequency. Since repeaters are usually located atop tall buildings, towers or mountains, they can receive signals from very low-powered stations on the ground at quite some distance from the repeater. Transmitting from such locations has the same advantage as receiving; the signals carry over greater distances. On the 10-meter amateur band, since signals below 30 MHz are reflected by the ionosphere, linking these signals to repeaters can achieve even greater distances.

Amateur Television

Hams can transmit and receive TV signals as well. In fact, they have two different ways to do it. Slow-Scan TV (SSTV) is used on the shortwave bands to transmit television pictures, one frame at a time, over great distances. The reason this mode is called slow-scan is because it takes about 8 seconds to transmit a single, freeze-frame TV picture using SSTV. The advantage, however, is that an SSTV signal only needs as much bandwidth as a SSB voice signal. The enormous bandwidth of a normal TV transmission would be too wide for any of the shortwave ham bands.

The other way hams transmit television signals is called Fast-Scan, or ATV, and like it's commercial cousin, ATV provides normal television, including real-time action with both color and voice, just like you see on your living room boob tube. ATV repeaters are becoming popular and help extend the range of ATV operations over several hundred square miles from the repeater site. It's not uncommon, especially in some of the more populated areas, for hams using ATV to carry on round-table nets where each of the ATV operators takes turns transmitting pictures and voice to the others.

Hams Talking to Spaceships!

Did you know that every single one of the U.S. astronauts has earned their amateur operator license and that almost every shuttle mission now operates ham radio at some time during the flight? Most often, the astronauts talk directly with students in classrooms and show live television pictures from the spacecraft while demonstrating the different projects being conducted during the mission. Astronaut Owen Garriott, amateur operator call sign W5LFL, was the first to operate ham radio from space during the Columbia Spacelab mission in 1983. His radio was a modified handi-talkie with a special antenna attached to the inside of the window of the shuttle. With less than 5 watts, Owen made direct contact with over 350 other ham operators and his signals were heard by over 10,000 amateur and shortwave listening stations in 23 countries around the world. It is truly a thrill to communicate with a real space ship...even if it is only one of our own!

There are so many other advantages and aspects to Amateur Radio that it is impossible to count them all. Beyond simply communicating in so many different ways with so many different kinds of people, there is the experimental nature of the hobby. Many of the inventions of yesterday that we take for granted today were the results of hams using Amateur Radio looking for a better way to do something. Exploration and science and technology are fundamental to the Amateur Radio spirit.

Amateur Operator Licenses

If after listening to amateur operators communicating on the shortwave bands, you would like to get in on the action and become a ham, a summary of the license classes and the examination requirements are shown in *Figure 6-2*. Prior to February 14, 1992 the Novice Class license, requiring a 5-wpm Morse code test, was the only entry-level ham license.

As of February 14, 1992, the FCC changed the Technician Class to a no-code class. Therefore, applicants can now enter the amateur service without passing a code test. They still must pass two written examinations. One is a 30-question written test containing questions from Element 2 of the question pool and the other is a 25-question written examination from the Element 3A question pool. Materials to prepare for a Novice, Technician, and General Class operator license are available at Radio Shack and the store managers have information on where examination sessions are held. Contact your

FIGURE 6-2. Amateur license classes and exam requirements.

License Class	Test Element	Type of Examination
Novice Class	Element 2 Element 1A	30-Question Written Examination 5-Words-Per-Minute Code Test
[1,2]Technician Class	Element 2 and 3A	55-Question Written Examination (In 2 parts-30 Element 2, 25 Element 3A) (No Morse code requirement)
[2]Technician Plus Class	Element 3A	25-Question Written Examination if a Novice. 5-wpm Code Test if a Technician.
General Class	Element 3B Element 1B	25-Question Written Examination 13-Words-Per-Minute Code Test
Advanced Class	Element 4A	50-Question Written Examination (No additional Morse code requirement)
Extra Class	Element 4B Element 1C	40-Question Written Examination 20-Words-Per-Minute Code Test

[1]No-Code License
[2]Effective 2/14/91
Note: Written examinations should be taken in strict ascending order of difficulty all the way to Extra Class. You should not be administered Element 3A until you have passed Element 2, etc. The code tests may be taken in *any* order. You may take the 20-wpm code test first if you can pass it. You can enter as a Technician without code, and then gain Technician Plus CW privileges by passing the Element 1A code test. You can enter as a Novice with code, and then gain Technician Plus by passing the Element 3A theory examination.

local Radio Shack manager if you're interested. Radio Shack also sells 10-meter (see *Figure 6-3*) and 2-meter (*Figure 6-4*) Amateur Radio transceivers, but, remember, you must be a licensed amateur to operate such equipment.

Depending upon your own interests, you can go only as far as you wish up the license class ladder. The new Technician Class no-code license allows you voice and all other privileges on all amateur bands above 30 MHz. You can't use the shortwave bands, but you don't have to learn Morse code. If you want to operate in the shortwave bands, the Novice Class privileges allow you some use of the shortwave bands for contacting distant lands. The Novice Class requires a simple 30-question written examination and a 5-word-per-minute Morse code test. Each higher class license allows more operating privileges and, perhaps, the prestige of having earned a higher-level license. But no matter which class of license you earn, the key word is "earn". An amateur operator license is granted only to individuals willing to put forth a little effort to learn what's required of them. That effort is what makes the difference. That effort, no matter which license is obtained, earns each new operator the initial respect that makes Amateur Radio special. You will find, if you get into it, that mutual respect, courtesy and good operating procedures make the amateur service a wonderful hobby you can enjoy for a lifetime.

FIGURE 6-3. A 10-meter amateur transceiver.

FIGURE 6-4. A 2-meter VHF-FM handheld transceiver.

Summary

You can cover amateur bands with your shortwave receiver if it has a BFO to allow reception of SSB and CW signals, but if you want to participate in transmitting also, then you will need a ham license and a transceiver instead of just a receiver. In this chapter, we have reviewed the activities and operational modes that you will encounter on the amateur bands. You will hear amateur CW, voice, RTTY, FAX, packet, AMTOR, and slow-scan TV signals.

In this book we have tried to point out the benefits and fun of listening to shortwave. We have touched a little on the bands below and above the shortwave bands and included some sample frequencies and suggestions on what to look for in a good shortwave receiver. We have also shown where some particular stations can be found, what kind of signals will be heard, and examples of the types of equipment needed to participate. Our goal was to show you that listening to shortwave can be a very interesting, entertaining and rewarding pastime, hobby, or educational experience—we hope we have succeeded.

Appendix

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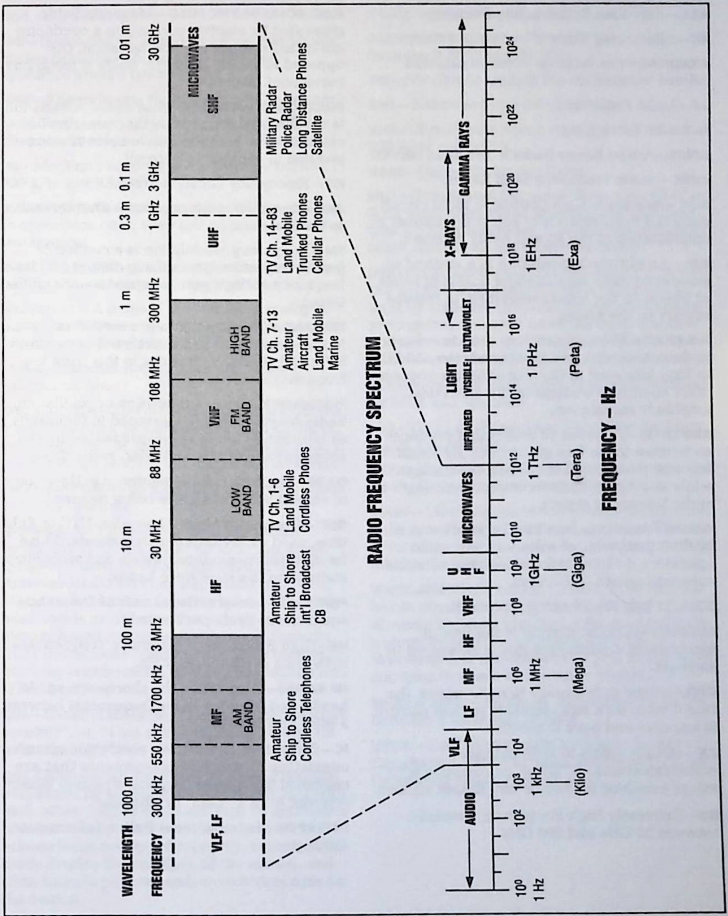
Electromagnetic Spectrum



Glossary

ABC—American Broadcasting Company

AC—Alternating Current

AERONAUTICAL MOBILE—Communications related to international flights.

AF—Audio Frequency

AFB—Air Force Base

AFRTS—Armed Forces Radio & Television Service

AFSK—Audio Frequency Shift Keying

AGC—Automatic Gain Control. A radio circuit designed to automatically adjust the amount of amplification of the signals being received.

AM—Amplitude Modulation is a method of generating radio signals using changing levels of power in the signal waveform to impose sounds on the signal.

AM BAND—The common term used in reference to the commercial broadcast band from 550 kHz to 1650 kHz used in the United States and most other countries. Stations in this band use amplitude modulation.

AMPLIFIER—A circuit or device that produces an increase in the flow of electrons. RF amplifiers increase the strength of radio-frequency signals, while audio amplifiers increase the strength of audio-frequency signals.

AMSAT—American Satellite Corporation. A non-profit organization of volunteer ham radio operators dedicated to pioneering satellite communications technology.

BBC—British Broadcasting Corporation

CURRENT—Electric current is the flow of electrons in a conductor and is measured in amperes.

CYCLE—Used in reference to radio waves, the time it takes for a radio signal to go from positive to negative and back to positive.

DX—Usually refers to long-distance communications. A "DXer" is someone who enjoys searching for rare or very distant stations.

EHF—Extremely High Frequency; generally, between 30 GHz and 300 GHz.

ELECTROMAGNETIC FIELD—Magnetic fields generated by electric currents in a conductor are called electromagnetic radiation. (As opposed to simple magnetic fields surrounding permanent magnets.)

ELECTROMOTIVE FORCE—Also called voltage, this is the force which creates the "pressure" on electrons that causes them to move from one position to another in a circuit.

ELT—Emergency Location Transmitter

FAX—Facsimile; pictures transmitted by radio or wireline

FM—Frequency Modulation is a method of generating radio signals using changes in the frequency of the signal to impose sounds on the signal.

FM BAND—The common name used in reference to the commercial broadcast band between 88 MHz and 108 MHz. Stations in this band use frequency modulation.

FREQUENCY—Rate of repetition or oscillation. Radio frequencies are measured in thousands or millions of hertz and represented by the abbreviations of kHz and MHz, respectively.

GAIN—The term used in reference to the amount of amplification of signals being received.

GMT—Greenwich Mean Time; also, UTC or Zulu time, used as the international standard time for most shortwave broadcasters and many other stations on the shortwave bands.

HERTZ—The international unit of frequency, equal to one cycle per second.

HF—High Frequency; generally, frequencies between 3 MHz and 30 MHz.

HF BANDS—Also called the shortwave, or SW bands, and referring to the frequencies between 3 MHz and 30 MHz.

IC—Integrated Circuit. An electronic circuit consisting of mulitple components that are combined into a single physical structure usually referred to as a "chip" or "module".

INTERPOL—International Police Information Agency

IONOSPHERE—An upper layer of the earth's atmosphere consisting of ionized particles that reflect radio waves with varying degrees of reflectivity depending upon the night/day cycle and solar activity.

ITU—International Telecommunications Union; makes decisions on the use of the radio spectrum around the world.

KHZ—Kilohertz; one thousand cycles per second

LF—Low Frequency; generally, frequencies between 30 kHz and 300 kHz

MF—Medium Frequency; frequencies between 300 kHz and 3 MHz

MARINE RADIO—Radio communications related to operations on or near inland lakes or coastal waterways.

MARITIME RADIO—Radio communications related to operations of ships on the high seas.

MULTIPLEX—A method of combining multiple signals so that several can be carried on a single wire or radio transmission.

NASA—National Aeronautics and Space Administration

OSCILLIATION—The continuous change from one state or position to another and back again, or, the "vibration" of an electric current or a radio wave through positive and negative alterations.

PROPAGATION—The transmission of radio waves over any distance.

Q-SIGNALS—Three-letter code words (all beginning with the letter Q; thus the name, Q-signals) used by radio operators in the Amateur Radio service, especially on CW or Morse code transmissions, to replace frequently-used words or phrases. Frequently-used Q-signals heard on the amateur bands include: QRM (intentional interference), QRN (naturally occuring interference), QSB (signals fading) and QTH (location).

QSL—Q-signal meaning, "Can you acknowledge receipt?", or, "I am acknowledging receipt [of your signal.]"

QSL CARD—A postcard-like acknowledgement exchanged by amateurs to confirm contact with each other. Similar cards are sent by shortwave broadcasters to shortwave listeners to acknowledge receipt of reception reports. QSL cards display the callsigns of the station, and often include pictures and/or technical data on the station.

RF—Radio Frequency

RFI—Radio Frequency Interference

SHF—Super High Frequency; generally, between 3 GHz and 30 GHz.

SHORTWAVE BANDS—The radio spectrum between 3 MHz and 30 MHz.

SW—Shortwave

SWL—Shortwave Listener/Listening

UHF—Ultra High Frequency; generally, between 300 MHz and 3 GHz.

USAF—United States Air Force

UTC—Coordinated Universal Time; also, GMT or Zulu time, used as the international standard time for most shortwave broadcasters and many other stations on the shortwave bands.

UTILITY STATIONS—Radio stations that fall outside the general broadcast and amateur services, such as standard time and frequency stations, propagation beacons, news services, weather stations, aviation and maritime stations, law enforcement and private commercial stations.

VHF—Very High Frequency; generally, between 30 MHz and 300 MHz.

VLF—Very Low Frequency; generally, between 3 kHz and 30 kHz.

VOA—Voice Of America radio stations supported by the United States Information Agency.

WARC—World Administrative Radio Conference; held periodically by members of the ITU to determine changes in the use of internationally allocated radio frequencies.

WAVELENGTH—Term used to describe specific bands of radio frequencies. Wavelength is the distance between identical reference points in a given wave from one cycle to the next. Wavelength is the distance a cycle of the wave occupies in space as the wave travels.

WORLD BAND—Refers to the shortwave bands between 3 MHz and 30 MHz.

ZULU—Used to designate time based upon Coordinated Universal Time, known as UTC, and Greenwich Mean Time, or GMT.

Index

LISTENING TO SHORTWAVE

Join in on the excitement of listening to shortwave radio! Find out about the strange pulses, beeps, and chirps that, in addition to voice, are present on the shortwave bands. Thrill to locating and listening in on messages from around the world.

LISTENING TO SHORTWAVE
Describes it all

Shows how, where and when to find stations. Tells you about receivers, antennas, and the different types of shortwave broadcasts. Learn what shortwave radio is, how radio waves are generated, and how the waves move through the air. Know what frequency and wavelength are, and how the radio frequency spectrum is divided into its different bands. Covered in six chapters as follows:

1. Listening to Shortwave – The Benefits
2. Where to Find Shortwave Signals
3. What Am I Listening To?
4. Expanded Listening on VHF and UHF
5. Equipment for Listening
6. Amateur Radio

About the Author

Ken Winters has been interested in listening to shortwave since his teenage years. This led him to ham radio, and he holds an Advanced Class license, N5AUX. He has been editing and publishing *THE D/FW FREQUENCY LIST* since 1983, and has authored several technical magazine articles. He served as contributing editor to the *1992 Communications Guide* by Popular Communications.

Ken has a wide variety of radio communications experience. He is very active in ham packet radio. He is the Emergency Coordinator for Tarrant County ARES, and is active in RACES—the radio amateur civil emergency service. He assists in training and disaster preparedness, and is active in the *SKYWARN* program to assist the weather service.

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